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ABSTRACT

The current period in mathematics education can be characterized as one of reform. Many feel that children in the United States are not learning enough appropriate mathematics; these critics are concerned with the specific areas of problem solving and children's conceptions of the nature and uses of mathematics. A pretest/posttest experimental design study examined the effects of SQUARE ONE TV (SQ1TV), a television series about mathematics aimed at 8- to 12-year-old children, on the problem-solving behavior and attitudes toward mathematics of 240 fifth graders from 4 public schools in Corpus Christi, Texas. Performance and attitude data were collected from a subgroup of 24 students exposed to 30 SQ1TV programs and from 24 students in a control group having no SQ1TV contact. Reported here is the SQ1TV interview regarding children's reactions to the series, presented in the fourth of a five volume report. Administered as the last measure in the study, the SQ1TV Interview was conducted individually with students for 1 half-hour session 1 or 2 days after viewers completed the posttest. Chapters 1 and 2 focused on methodology and students' initial responses to SQ1TV. Chapters 3-8 reported childrens' opinions and reactions to SQ1TV with respect to: (1) Fun; (2) Education; (3) Problem Solving; (4) Mathematics; (5) Participation; and (6) Applications of Mathematics and Problem Solving. Results indicated that over half the children came to see that learning mathematics and having fun were not incompatible activities. These findings suggest that SQ1TV provides a context that can encourage not only positive perceptions of mathematics but also the active doing of mathematics. (MDH)

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Children's Problem-Solving Behavior and Their Attitudes toward Mathematics: A Study of the Effects of SQUARE ONE TV

VOLUME IV

The SQUARE ONE TV Interview:

Children's Reactions to the Series

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Children's Television Workshop
New York, 1990

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PREFACE

This is the fourth of five volumes that describe an evaluation entitled "Children's Problem-Solving Behavior and Their Attitudes toward Mathematics: A Study of the Effects of **SQUARE ONE TV**." The study was designed to assess the effects of **SQUARE ONE TV** on children's use of problem-solving actions and heuristics and their attitudes toward mathematics. In addition, children were interviewed about their opinions of and reactions to **SQUARE ONE TV** itself.

The contents of the five volumes are as follows:

Volume I: Introduction: Purpose and General Design of the Study

Volume II: The Effects of **SQUARE ONE TV** on Children's Problem Solving

Volume III: Children's Attitudes toward Mathematics and the Effects of **SQUARE ONE TV**

Volume IV: The **SQUARE ONE TV** Interview: Children's Reactions to the Series

Volume V: Executive Summary

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CHAPTER 1

OVERVIEW AND METHODOLOGY

Overview

The first volume of this report has provided an overview of the entire study, including a description of its overall purpose, design, and methodology. The reader is referred to that volume for this basic information. The purpose of the present volume is to describe in detail viewers' perceptions of **SQUARE ONE TV** (SQ1TV). This first chapter presents the purposes of the SQ1TV Interview. Because this part of the study draws directly upon SQ1TV, a short review of the series and its formats will be offered. Methodological issues such as data collection and data analysis will be discussed. The chapter will close with an overview of the remaining chapters of this volume.

Purpose of the SQ1TV Interview Study

In the SQ1TV Interview we were interested in understanding children's responses to SQ1TV. After viewing 30 programs of the series, the children were interviewed and their responses were analyzed. Volumes II and III have assessed the impact of exposure to SQ1TV on children's problem solving and attitudes toward mathematics. This volume provides a further investigation of the impact of SQ1TV by examining viewers' perceptions of the series itself.

Description of SQ1TV

Because this volume explicitly refers to SQ1TV, it will be useful to have a description of the series' design, a presentation of its goals, and a synopsis of its various formats. The series employs a "magazine" format in which a variety of different segments make up each

Table 1.1

Recurring formats in SQ1TV

Mathnet	Serialized parody of the detective series "Dragnet," in which two mathematicians, Kate and George, use mathematical problem solving to solve mysteries. Occurs at the end of every SQ1TV program for approximately 10 minutes, with a given story beginning on Monday and concluding on Friday.
Mathman	Animated video game in which Mathman's mission is to eat numbers that fit certain conditions (e.g., multiples of 3), and, thereby, avoid being devoured by his enemy, Mr. Glitch.
Game Shows	Games in which real children or cast members serve as contestants. Games with real children include: **Triple Play** (contestants form equilateral triangles by using addition and multiplication), **Piece of the Pie** (children's answers to a survey are represented on a pie chart), **Close Call** (given a referent, contestants estimate numbers of objects, length, or area), **Square One Squares** (children decide whether cast members are telling the truth or bluffing about answers to questions concerning a wide range of mathematical content). Game show parodies using cast members as contestants include **But Who's Counting**, which involves place value and probability.
Music Videos	Songs in which SQ1TV cast members or popular musicians sing about mathematics. Songs include **"One Billion is Big"** by the Fat Boys, and **"Nines,"** a country/western tune expressing the idea that the sum of the digits of any multiple of 9 always is 9.
Phoner	One-sided phone conversation in which, e.g., a sequence of operations is dictated, resulting in the same number every time.
Backstage with Blackstone	Magician Harry Blackstone Jr. performs tricks that involve fundamental properties of numbers, mathematical operations, and sleight-of-hand.
Dirk Niblick	Animated series of segments about a hero who helps people solve problems by using mathematics.
Cabot and Marshmallow	Parody of "Abbott and Costello" in which Cabot plays a variety of mathematical tricks on Marshmallow.
Oops!	Studio sketches in which mathematical mistakes (e.g., in "borrowing" in a subtraction problem) lead to mishaps.
Person on the Street	People on the street are asked questions such as "What is a palindrome?"
Bumpers	Short pieces inserted between longer sketches that present information and invite participation (e.g., "You've seen 25% of SQ1TV so far; how much is left?").

30-minute program. The formats include animation, studio sketches, music videos, and "Mathnet," a daily serial.

The material produced for SQ1TV has been designed to meet three goals. While each segment does not necessarily reflect aspects of all of the goals, the series attempts to accomplish the follow objectives:

I. To promote positive attitudes toward, and enthusiasm for, mathematics;

II. To encourage the use and application of problem-solving processes; and

III. To present sound mathematical content in an interesting, accessible, and meaningful manner.

A full elaboration of these goals can be found in Appendix IV.A.

Table 1.1 describes some of the recurring formats seen in SQ1TV.[1] A sample SQ1TV program is presented in Appendix IV.B. Recall that a description of every program included in the treatment can be found in Appendix I.B of Volume I.

Methodology : Data Collection

We will now consider the methodological issues associated with data collection. This will include a brief overview of the sample, but most of the discussion in this section is devoted to the rationale for interviewing, and the design of the interview protocol.

Review of Sample and Procedure

As detailed in Volume I, 24 fifth-grade children viewed 30 programs of SQ1TV over an eight-week period. These 24 children are the focus of the present volume. The children

[1] Note that we use the term "format" here somewhat differently than it is used in coding the content of the series. As shown in Appendix I.B of Volume I, the series is divided into eight formats (e.g., Animation, Live Action Film). Here, we use "format" to refer to a recurring series of related segments.

came from two different schools, one with children of low socioeconomic status (SES) and the other with a middle-SES population; 12 children from each school participated. The sample from each school was 50% male and 50% female; 29% of the children were Anglo, 4% were African-American, and 67% were Latino.

Children viewed SQ1TV in class, but this exposure consisted of unaided viewing. That is, teachers were instructed not to incorporate the series into their lessons or even to comment on it in any way.

The SQ1TV Interview was the last measure administered in this study. It was conducted by one of two interviewers in a half-hour session[2] held one or two days after viewers completed the posttest. Children were interviewed individually.

While the two interviewers had been introduced to the children previously, neither had interviewed them in either the pretest or posttest. The children were not told of the interviewers' connection to SQ1TV until after the interview was completed. Indeed, none of the children indicated that they saw the interviewers as part of the SQ1TV staff or associated them with the Children's Television Workshop. In fact, many children seemed to assume that the interviewers were not familiar with SQ1TV formats and made a point of explaining various segments during the interview.

Rationale for Interviewing

There were two primary reasons why an interview methodology seemed appropriate for this portion of the present study. First, interviews provide a forum in which children can take time to articulate, elaborate upon, and clarify their ideas. Moreover, when dealing with concepts that may be difficult to express, interviewers can ask follow-up questions to help facilitate the children's expression of their ideas. In this study, interviewers were

[2] Note that several of the interviews were slightly longer; some children simply talked more while others' responses required more probing than most.

trained to support children's efforts to take time to think about a question or to articulate a difficult idea.

Second, an interview situation does not require that children offer a "complete" answer to each question as it is asked. Rather, children can return to ideas expressed earlier and develop them further as they proceed through the interview. Thus, the interview can serve as an "extended conversation" that provides children with the opportunity to express their ideas as fully as possible.

Interview Protocol

As previously stated, the purpose of this portion of the study was to explore children's ideas about SQ1TV in order to understand the ways in which the series might have affected their conceptions of mathematics and problem solving. The protocol, presented in full in Appendix IV.C, included questions about children's general responses to SQ1TV, their reactions to particular SQ1TV formats, their ideas about mathematics and problem solving, and their reflections upon their own learning. Our express interest was in understanding how the children thought about mathematics and problem solving, both in SQ1TV and in their own lives.

The interview consisted of three types of questions: open-ended questions, directed questions, and follow-up questions.

Open-ended questions. Open-ended questions set very few boundaries on children's responses. The interview began with three open-ended questions, including "What did you think about the show?" (Question 1). We were interested, with these questions, in understanding what children decided was noteworthy to raise in the interview.

Directed questions. By comparison, the directed questions in the protocol were more focused, such as "What kinds of problem solving did you see on SQ1TV?" (Question 20) or "How is the mathematics on SQ1TV like the mathematics you do in school?" (Question 14).

This type of question was designed to explore specific issues, but was open enough to support a variety of responses from the children.

It is important to note that some directed questions offered alternate ways to approach the same concept. For example, children were first asked, "What kinds of problem solving did you see being done on SQ1TV?" (Question 20). They were later asked, "What kinds of figuring out did you see being done on SQ1TV?" (Question 22). Asking both questions offered the opportunity for children to approach the concept of problem solving from different angles. For some children, the "problem solving" question was difficult to answer; the "figuring out" question was easier. For other children, the second question elicited more ideas about the general concept of problem solving, allowing them to expand upon what they had said in response to the first query. By including both questions, then, we minimized the chances of missing important information.

Follow-up questions. Follow-up questions were used with every question in the protocol. Children might be asked to give examples, to explain their ideas more fully, to clarify a term, or to reflect upon the reasons for responding in a certain way to a given question. These follow-up questions were important in that they supported children's efforts to express difficult ideas or to reflect upon concepts that they do not typically discuss. As a result, we were able to learn more about what the children thought. Indeed, the majority of the interviewers' questions took the form of follow-up questions, guided by the children's responses to the open-ended and directed questions.

Methodology: Data Analysis

We will now turn to a discussion of methodological issues relating to data analysis. Thematic analysis was the primary data analysis strategy used. This section contains the rationale for that type of analysis as well as an overview of the process of thematic analysis.

Rationale for Thematic Analysis

The data consisted of transcripts of the audio-taped responses collected in the SQ1TV Interview. Because children did not confine their ideas to particular interview questions, but rather elaborated upon them at various points in the interview, these data were not analyzed on a question-by-question basis. Instead, data were read across the entire interview. Analyzing the interview as a whole, rather than focusing on discrete questions, seemed an appropriate choice in order to understand more fully children's thinking about SQ1TV.

Thematic analysis, in which central themes are identified in and elaborated from the children's responses, proved to represent most fully the ideas expressed by the children during the interview. These central ideas or themes emerged from repeated readings of the data. Thus, this approach emphasized the data-driven nature of the themes (Glaser & Strauss, 1967; Strauss, 1987).

Process of Thematic Analysis

The thematic analysis for these data involved four distinct steps. The first step was identifying and elaborating the central themes. The second was coding the data. The third step was forming an interpretation of these data for each theme. The fourth step was examining the data for possible between-group differences in terms of sex and SES.

Identifying central themes. Initial readings of the interview transcripts highlighted six central themes in the data. These themes were the ideas that were most prominent in the responses of the children interviewed. The themes were: (a) SQ1TV and fun, (b) SQ1TV and education, (c) SQ1TV and problem solving, (d) SQ1TV and mathematics, (e) SQ1TV and participation, and (f) SQ1TV and applications of mathematics and problem solving. Once this preliminary set of themes was established, the data were read again to verify their salience within the children's responses and subthemes were identified and elaborated. Chapters 3 through 8 present full descriptions of the themes and subthemes.

All themes were developed by working from the data set as a whole, but the directed protocol questions were useful nonetheless in focusing children's responses about particular issues. Specific questions were designed to target aspects of four of the themes (education, problem solving, mathematics, and applications); however, children also spoke of these themes spontaneously throughout the interview. The remaining two themes (fun and participation) were not linked to any particular protocol questions; the responses classified under these two themes were thus largely spontaneous.

Coding. The second step in analysis was coding all of the interviews for each of the six themes. The elaboration of each theme and its subthemes, developed in the first step, provided the criterion for coding. For example, the theme of SQ1TV and fun contained three different subthemes: (a) the humor of the language and action in the series, (b) the engaging change of pace it offered, and (c) the entertainment value of the series. Data were coded for these dimensions or subthemes of fun. The result was a data display (Miles & Huberman, 1984), which is a summary sheet collecting each child's responses within each subtheme. The subthemes under each theme are elaborated in the relevant thematic analysis chapters and described more fully in the codebook presented in Appendix IV.D.

Given the relationships among the six themes in this analysis, it was possible that one response could be coded for more than one theme. A response could contain, for example, an elaboration of the fun theme as well as the problem-solving theme.

Interpreting data. The third step in data analysis used the data displays constructed for individual children to look across the responses of the entire sample. The purpose was to create an overall description or summary interpretation of each theme that would best represent the meanings expressed by the sample of 24 children.

Examination by sex and SES. Throughout this entire study, we were interested in examining the effects of sex, SES, and ethnicity, as noted in Volumes I through III. However, because the SQ1TV Interview was conducted only with viewers, our sample size

was effectively halved for this portion of the study, and this should be kept in mind when considering the results of this fourth step in analysis. Data from the SQ1TV Interview were analyzed by sex and SES, but because only seven nonminority children were included among the viewers, a similar analysis could not be conducted by ethnicity. However, because SES and ethnicity were largely confounded in this study, results reported for SES may be interpreted as providing some indication of the results that would be likely to be found for ethnicity as well.

We present the results of our analyses by sex and SES within each of the chapters that follow. In light of the limitations described above, our discussions of these data will be brief, although we felt that it was important to include them in this volume.

Interrater Reliability

To assess the reliability of our coding scheme, a second researcher independently coded six of the 24 interviews for each of the themes and subthemes. Agreement between the two raters was sufficiently high to assume the scheme to be reliable. For further information regarding this analysis, see Appendix IV.E.

Overview of Volume

In this volume, we will look at the responses of children to SQ1TV in two ways. We will consider their initial responses to the series (Chapter 2). Then, we examine the central themes in their responses (Chapters 3 through 8). The volume ends with a chapter discussing summative conclusions concerning children's ideas about SQ1TV. Each of these chapters will be described briefly here.

Chapter 2 sets the stage for many of the ideas that will be taken up in succeeding chapters. By looking at what children had to say about SQ1TV in response to open-ended

questions posed at the beginning of the interview, we will hear them begin to talk about two salient themes that emerge throughout: that SQ1TV is fun and about mathematics. This introduction to the children's responses is coupled with a review of the SQ1TV formats that children discussed during the interview.

Chapters 3 through 8, the bulk of this volume, contain the thematic analyses of children's responses to SQ1TV. Each chapter is devoted to a single theme: SQ1TV and fun, SQ1TV and education, SQ1TV and problem solving, SQ1TV and mathematics, SQ1TV and participation, and SQ1TV and applications of mathematics and problem solving. Within each chapter there is a description of the subthemes (i.e., the ways in which each theme was broken down for analysis) and a discussion of children's ideas with respect to those subthemes. There are clearly areas of overlap among these different themes, and these are noted when appropriate. Each chapter concludes with a discussion of the relationship between children's responses and the goals of SQ1TV.

Finally, Chapter 9 summarizes our results and presents the major conclusions that we draw from the data.

CHAPTER 2

INITIAL RESPONSES TO SQUARE ONE TV

Introduction

There are two purposes to this chapter. One is to present the children's initial responses to SQ1TV, that is, their comments about the series in response to the open-ended questions posed at the beginning of the interview. Although we were interested in the children's responses across the interview, we felt that their initial responses were particularly important because they represented the points that were most salient to the children. As we shall see, children described SQ1TV in their early responses as fun and about mathematics. These data not only highlight the children's immediate perceptions of SQ1TV, perceptions that are in accord with the goals of the series, but also illustrate prominent ideas that the children returned to in their comments throughout the interview. Thus, this consideration of children's initial responses also sets the stage for further investigation into the meaning children drew from the series.

The second purpose of this chapter is to elaborate on the SQ1TV formats that children mentioned most frequently during the interview. This discussion will provide the reader with a context in which to place the children's comments about the series while also presenting information about why children liked particular SQ1TV formats.

Fun and Mathematics

Children's Initial Responses

What did children think about SQ1TV? How would they describe the series? What did they perceive as its focus? An examination of children's responses to such questions

reveals that they framed their initial reactions to the series in terms of fun and mathematics.

When asked to reflect upon their impressions of SQ1TV (Question 1) and to offer three words to describe the show (Question 2), the majority of children (22/24) explicitly said that SQ1TV is funny and fun to watch. A number of children (15/24) also described SQ1TV as exciting or interesting, elaborating upon the ways in which the series was engaging to them as viewers and/or participants.

While children's first reactions to the series emphasized that they liked the fun of SQ1TV, approximately one half of the children (11/24) also spoke of the educational quality of the series or about how it teaches mathematics as being positive aspects of SQ1TV. Thus, mathematics appeared to be a feature of the series that many children liked. When asked, in the third question of the interview, to identify the focus of the series, all children spoke of mathematics as "what SQ1TV is all about." Several children included fun (5/24) or education (7/24) in their explanation of the focus of the series, but this was part of the larger purpose of learning mathematics. Through their responses, children indicated that they understood that the express purpose of the series is to present mathematics.

Significance of Initial Responses

The initial responses of the children to SQ1TV are worthy of our attention for a number of reasons. First, we believe that children offered genuine reactions to the series. As noted in the preceding chapter, they had prior interviewing experiences and spoke readily; they seemed comfortable with the situation and eager to share their views. Perhaps more importantly, they did not know of the interviewers' connection with SQ1TV. We had confidence that their initial responses were, indeed, representative of what they thought about the series.

A second reason for the significance of these initial responses to SQ1TV as fun and about mathematics is the fact that children repeated these ideas throughout the entire

interview. They did not appear to be inconsequential responses for the children, nor were they ideas that were abandoned as the interview progressed.

One place in which this initial emphasis upon fun and mathematics was reiterated was in children's descriptions of the appropriate audience for SQ1TV (Questions 18 and 29). A majority of children (19/24) talked about "kids my age" or children in grades 3 through 6 as people who should watch the series because they could learn mathematics. Some of these children focused on the immediate educational benefits of SQ1TV; others talked about the usefulness of the series as preparation for the mathematics presented throughout junior high school. The importance of their comments is that they again highlighted the perception that SQ1TV teaches mathematics; this feature made the series worthy of recommendation to others.

The perception of SQ1TV as fun was also a part of the children's consideration of a potential audience for the series. Fourteen children advocated viewing SQ1TV because it was fun, and for 10 of these children, fun was explicitly related to the series' mathematical content. It is also noteworthy that some of the children did not limit SQ1TV's audience to the target group of intermediate-grade students. Four children went on to recommend SQ1TV for preschoolers, first, and second graders because it would be a fun opportunity through which to learn mathematics. Four other children suggested that adults, especially those who are not proficient in mathematics, might want to watch the series in order to improve their skills.

A third reason for the significance of the initial responses of children to SQ1TV is found when they are considered in light of the goals of the series. Two of the stated goals of SQ1TV are to promote positive attitudes and enthusiasm for mathematics (Goal I) and to present mathematical content in an interesting and accessible manner (Goal III). Children's initial reactions to the series indicated that they associated SQ1TV with fun and with

mathematics. In this way, children seemed to focus on aspects of SQ1TV that its creators also valued.

Implications of Initial Responses

Notwithstanding the importance of the children's initial responses to SQ1TV, it is important to explore more fully the meaning of those responses. To perceive SQ1TV as fun and as about mathematics is powerful. Our research concerns extend beyond that finding, however, to understand more specifically what these children meant when they talked about SQ1TV as "fun" and "about mathematics" and what connections might exist between the two. These issues will be explored throughout this volume.

SQ1TV Formats

In order to make sense of children's initial responses to SQ1TV, and their responses throughout the interview, it is necessary to know about the context in which children spoke about the series. Thus, before proceeding to detailed discussions of the themes that emerged from the data, this section will present the SQ1TV formats that they spoke about. These data came from answers to specific interview questions about the children's favorite parts of SQ1TV, and from comments about various SQ1TV formats that were made throughout the interview.

"Mathnet"

Children were virtually unanimous in their choice of "Mathnet" as the SQ1TV format that they liked the most. When asked to name their favorite part of the series, 21 children listed "Mathnet." One child named "Mathnet" as his second favorite part of the series, and

even the two children who did not rank "Mathnet" as a top choice spoke favorably about this part of the series.

All but two of the children went on to talk about specific "Mathnet" stories. "The Case of the Willing Parrot" was mentioned explicitly by 20 children. Each of the other five "Mathnet" stories was mentioned in the interviews by at least three children. It is likely that "The Case of the Willing Parrot" was mentioned much more frequently because it was the last "Mathnet" shown to the children and thus may have been freshest in their minds (see Table 2.1).

Table 2.1

Number of children mentioning "Mathnet" stories

Week story viewed	Story	Number who mentioned story
1	Problem of the Missing Monkey	6
2	Case of the Great Car Robbery	4
3	Case of the Map with a Gap	3
4	Problem of the Passing Parade	3
5	Case of the Missing Baseball	3
6	Case of the Willing Parrot	20

Overall, 22 of the 24 children in this study spoke of at least one "Mathnet" story and more than one half of the children (13/24) talked about more than one. The children offered extensive descriptions of "Mathnet" stories and included many details that attested to their interest in the "movie," as many of them described it. For the majority of children, their descriptions of "Mathnet" episodes were among the most detailed comments that they offered during the interview.

Important clues in the "Mathnet" mysteries were recognized and described by many of the children. Eighteen of the 20 children who talked about the "Willing Parrot" story, for

example, mentioned the Fibonacci sequence that was a central clue in the mystery.[3] These children noted the parrot's recital of "1, 1, 2, 3, 5, eureka!" and 13 of them went on to explain the mathematics involved in the sequence and to describe how the Mathnetters used this pattern to solve the mystery. As one child put it:

> It was about a parrot and [he] used to say some numbers that were 1,1,2,3,5. [He] used to say that and the -- they [Kate and George] were trying to figure out what -- what...what those numbers meant. And they -- they saw like the pattern in the wall, made of bricks...They found the pattern, the same pattern as 1,1,2,3,5. Then they found another pattern and that pattern had one remainder...There's six [bricks] and five could only fit on -- one row...In the other [sixth] brick, they opened it and there's a -- a paper.

Another child explained how the pattern worked:

> You go 1+1=2, 1+2=3, 2+3=5, 3+5=8, 5+8=13. And you can keep on going on. It's a pattern...start off with one and, and you can keep on -- and you can keep adding them...The parrot was always going 1,1,2,3,5...and they used the pattern to find the money. And they found a key and they went to the bank and they opened the box there. And there was a tape recorder and the tape -- and there was money in there, and a joke for the parrot.

This type of detailed description of the action of "Mathnet" was not unusual in the responses of these children and is indicative of their attention to and engagement with this format. It suggests why children voted "Mathnet" as the most popular part of the series. For many of them, "Mathnet" was a prime reason why, upon coming to the end of their six-week viewing of SQ1TV, the request was made (in the words of one child) to "tell whoever makes it to make more."

"Mathman"

While "Mathnet" was the clear favorite among these children, "Mathman" was a strong

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[3] In this story, the Mathnetters, aided by a young boy, search for a hidden inheritance that is eventually found in a safe-deposit box. The Fibonacci sequence, which is recited repeatedly by a parrot, is the key to several of the clues that lead to the inheritance, including a pattern of bricks on a wall.

runner-up. Four children listed "Mathman" as their favorite format;[4] another 12 ranked it as their second choice. During the course of the interview an additional three children talked about what made "Mathman" highly enjoyable for them. Thus, 19/24 children spoke favorably about "Mathman," a total that surpassed any of the remaining SQ1TV formats.

Sixteen children went on to describe why they liked "Mathman." Nine said that it was funny and entertaining, like many of the video games that they have played. Three children identified its mathematics content as the primary reason for their enjoyment of "Mathman." The remaining four children commented that they liked "Mathman" because it was a format in which they could participate.

Other SQ1TV Formats

Children mentioned many other formats besides their favorites, "Mathnet" and "Mathman" (Table 2.2). "Phoner" was a popular format, mentioned by almost half of the children. A variety of other formats were remarked upon as well. With the exception of one child, all others talked about at least one SQ1TV format besides "Mathnet" or "Mathman." Most children (19/24) noted four or more different SQ1TV formats during the course of the interview (Table 2.3).

Of the 23 children who spoke favorably about formats other than "Mathnet" and "Mathman," 18 went on to explain why. Five children spoke about liking "Backstage with Blackstone," with three of them commenting on its tricks and magic or its entertainment value, while the other two talked about its mathematical content. Three children liked the game show "But Who's Counting?" because of the opportunity for participation, and a fourth child liked it because it was amusing. Three children enjoyed the Fat Boys music video because they found the singers entertaining.

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[4] One child offered two "favorite SQ1TV segment" responses. Thus, while there are 24 children in the study, there were 25 "favorite SQ1TV segment" votes: 21 for "Mathnet" and 4 for "Mathman."

Table 2.2

Favorable mentions of SQ1TV formats

Format	Number of Children
"Mathnet"	24
"Mathman"	19
"Phoner"	11
Songs/videos	
General	9
Fat Boys	4
"Backstage with Blackstone"	7
Game shows	
"But Who's Counting"	7
"Triple Play"	4
"Piece of the Pie"	3
"Close Call"	1
General	1
Sketches	
General	6
"Cabot and Marshmallow"	4
"Superguy"	2
"Dirk Niblick"	5
"Oops!"	4
"Person on the Street"	1
Bumper: How much SQ1TV is left	1

Table 2.3

Distribution of SQ1TV formats among children

	Number of formats mentioned							
	0	1	2	3	4	5	6	More than 6
Number of children	0	0	1	4	7	9	1	2[1]

[1] One child mentioned nine segments; the other mentioned 12 segments.

Looking across the responses of these 18 children, it is clear that most children (14/18) liked various formats because they found them funny or entertaining. Others liked the formats because of the mathematics involved (5/18), or because of the opportunities for participation that were afforded (5/18).[5]

Summary

Children's initial responses to SQ1TV indicate that they appreciated the fun nature and mathematical focus of the series. This is important in that two of the goals of SQ1TV are to encourage enthusiasm for mathematics and to present mathematics in a clear and engaging manner. These initial responses are important, too, because they are the reasons children gave for liking particular SQ1TV formats. The thematic analyses presented in subsequent chapters are meant to elaborate upon these ideas, to highlight and distinguish other reactions that children had to SQ1TV, and to draw out the connections that children made between their initial and subsequent responses to SQ1TV.

[5] Note that these figures sum to more than 18 because some of the 18 children who gave reasons why they liked particular SQ1TV formats talked about liking more than one format, and provided various reasons for doing so.

CHAPTER 3

SQUARE ONE TV AND FUN

Introduction

All of the children agreed that SQ1TV is fun. What that means, in the context of their discussion of the series, is explored in this chapter. While this chapter is devoted to elaborating how the children saw SQ1TV as fun, it will become obvious that to do so involves talking about other themes in these data. SQ1TV was seen as fun because it is educational, it is about problem solving and mathematics, it invites participation, and it encourages application to real life.

Fun, as these children spoke about it, has three major subthemes: humor, entertainment value, and change of pace. In speaking about the humor of SQ1TV, children talked about the dialogue and actions that they found to be funny. They referred to the jokes they heard and commented on the parodies as humorous aspects of SQ1TV. The subtheme of entertainment value refers to the ways in which the children were amused and engaged by the series, including a discussion of how children perceived tricks on SQ1TV as entertaining. The final subtheme focuses on the fun children derived from SQ1TV as a change of pace from their typical classroom experience. Here, children commented on the ways in which they found the series to be relaxing and not boring.

These three subthemes capture the ways in which children expanded upon their understanding of SQ1TV as fun. This chapter will present each of these subthemes in turn. It will then conclude with a discussion of how the goals of the series are represented in this theme.

Humor

The humor in SQ1TV is the strongest subtheme, in that 22 of the 24 children commented on it explicitly. Some referred to the humor of the dialogue or actions of the characters. Others retold jokes that they had heard on the series. Still others spoke of funny ways in which SQ1TV segments parodied TV shows and video games.

Dialogue and action. A majority (18/24) of the children commented on the humorous dialogue or action in the SQ1TV sketches. Some examples of the funny things children noted included the banter of Cabot and Marshmallow, the way in which Mathman said "Mathman, Mathman" as he searched for the right answers in the maze, and various comments including a reference to "birdnapping" when the parrot in the "Mathnet" story "Willing Parrot" was stolen. The humor in the dialogue amused many of the children, as seen in one child's comment on the "funny way they say things."

Children also perceived the actions seen in various SQ1TV formats as humorous. Characters were observed, as one child put it, "acting weird" and doing funny things. Children were amused by game shows such as "But Who's Counting?" because of the array of contestants and the ways in which they played the games. One child reported that videos such as the one by the Fat Boys, in which they sing and eat hamburgers, made his classmates laugh and was singled out as "cool." A few children were taken by the fact that the parrot in the "Willing Parrot" story could play the piano and that there was miniature furniture in its cage. Even the way in which Mathman would flip and run as he was pursued by Mister Glitch was a source of amusement for many children. Children noted the clever dialogue, silly actions by characters, and imaginative details because their humor was broad and appealed to these fifth graders.

Jokes. One quarter of the children made specific references to the jokes told on the series. For example, two children commented that jokes were part of the "Willing Parrot" story; the Mathnetters tried to locate the bird by listening for him to respond with the punch

line to his favorite jokes, such as "Why does the fireman wear red suspenders? To keep his trousers up!" and "Why did the chicken cross the road? 'Cause he was stapled to the frog!" One child referred to these quips as "math jokes"; they were perceived as jokes because they had funny punch lines, and "math jokes" because they were set in a mathematics mystery. While children understood the function of the jokes within the "Mathnet" case, the jokes were enjoyed primarily for their humor. Many children liked the fact that, on SQ1TV, they "do a lot of crazy jokes all the time."

Parodies. One half of the children commented on the ways in which SQ1TV, through "Mathnet" and "Mathman," successfully imitates familiar television programs and video games. While a few children made passing references to "Mathman" as similar to many of the video games that they enjoy, nine children offered more specific comments on the nature of the "Mathnet" parody. A few children identified "Mathnet," in which Kate Monday's opening lines include the statement that "the names are made up but the problems are real," as a parody of the TV series "Dragnet." Some children especially liked that the parody was sustained even to the calculators that Kate and George carried in their holsters.

While Kate and George were seen as using mathematics to solve mysteries on "Mathnet," and while a few children pointed out that in real life police also solve mysteries, children commented on the humor and not on the mathematics of the parodied elements. For example, the children knew that objects such as calculators are associated with mathematics. Yet, they enjoyed the flourish with which Kate and George pulled them from their holsters, as though they were the guns carried by police officers. They focused on the humor and not the mathematical potential of objects such as calculators.

Entertainment Value

Approximately one half of the children talked about the entertainment value of the series. SQ1TV was entertaining in the same ways that television programs typically are. It

was a source of amusement for the children, it could make them laugh, and it captured their attention. Children focused on the ways in which SQ1TV had the potential to keep them entertained, and to keep them engaged in watching the series. Comparisons to other engaging forms of media helped the children talk about SQ1TV's entertainment value.

Some children commented on the ways in which formats such as the game shows could keep them laughing. One child even compared them to the sitcom "Three's Company" because both are about "laughing matters." A few children commented that the animated "Dirk Niblick" format was like the entertaining cartoons that they see on television. Many children noted that "Mathnet" was like a movie, replete with story line and suspense, which kept them anticipating the next day's episodes. The children found SQ1TV to be entertaining in the same ways that they found other media in their everyday lives to be entertaining.

Tricks. A few children commented specifically on the tricks they saw on SQ1TV as reasons why they found the series entertaining. "Backstage with Blackstone," in which magician Harry Blackstone performs a magic trick and then demonstrates a mathematically based magic trick, was described by one child as having "real magic" and "fake magic": "First he does a real magic thing and then he does like a simple thing that anybody could do, so I like the first part where he does real magic...[better than] the fake magic, you know, that...magic that anybody can do."

Two children described a "Blackstone" segment in which one can figure out which hand holds a penny and which holds a nickel by asking the person holding the coins to multiply the value of the coin in one hand by seven. The answer comes quickly if it is the hand with the penny, but it takes longer if it is the hand with the nickel. The children understood that this was not magic, but knowledge of how long it takes someone to do multiplication. They found such "tricks" to be interesting, but not as entertaining as the "real magic" tricks that Blackstone performed.

The entertainment value of mathematical "tricks" was also noted in segments of

"Cabot and Marshmallow" as well as "Phoner." One child liked how Cabot tricked Marshmallow by declaring with a flip of a coin, "Heads I win, tails you lose." The child understood the unfairness of Cabot's offer; the fact that Marshmallow had been deceived by it made it entertaining. Two children commented on "Phoner" as being a trick that was both entertaining and puzzling. They were intrigued with how one can end up with the same number after performing a series of computations, but they commented that they did not understand the arithmetic principles involved. "Phoner" was entertaining because it was both a mysterious use of mathematics and a "neat trick."

Change of Pace

A third of the children in this study explained that SQ1TV was fun because it offered a change in pace from the normal school day.[6] Moreover, children viewed the change of pace as positive; watching SQ1TV was fun because it was enjoyable, engaging, and different from their usual classroom activities.

As one child said, viewing SQ1TV meant that "you get to sit down and watch TV instead of just doing work." Another commented that SQ1TV was relaxing because "like if you're doing work and you're all tired and everything, it isn't boring...you can just sit there and relax." A third child explained that "it takes your mind off things" and went on to say that "if you have a lot of stress, you watch it and it's fun and also you're learning at the same time." Part of the appeal of SQ1TV, and a reason why children found the series fun, was that it offered a different kind of interaction, one that they did not associate with the work they do in school.

Children emphasized the differences between SQ1TV and schoolwork, speaking about how they found SQ1TV to be relaxing and not dull. This is not to say that their experience

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[6] Note that the children in this study viewed SQ1TV during the course of the school day, but that it did not replace their usual mathematics class.

of school, especially in terms of learning mathematics, was necessarily stressful or boring. Rather, these children commented on the impact that SQ1TV had because it was a change of pace, and an enjoyable change of pace, from their typical school activities. Because SQ1TV could "brighten up the day," this might account for why, upon hearing that there were no more programs to view, one child related that in one class "everybody just laid their head on their desk and went 'Oh, no.'"

Sex and SES Differences

In examining children's responses across this theme, no differences were found as a function of either sex or SES. Equal numbers of girls and boys found SQ1TV to be funny and entertaining and presented similar reasons for their opinions. A similar lack of difference was found for SES.

Summary and Relation to SQ1TV Goals

Throughout the interview, children could be heard talking about the fun they found in SQ1TV. For most children, this meant noting and commenting on the humor of SQ1TV, whether in the dialogue and actions, the jokes, or the parodies. Almost one half of the children spoke about the fun on SQ1TV by focusing on the entertainment value of the series. They found SQ1TV fun because it amused and intrigued them in the ways that, for example, TV series, animation, or magic tricks typically entertain them. Finally, for some, perceiving fun in SQ1TV meant reflecting on how the series was an enjoyable and engaging change of pace from the everyday school experience.

The first goal of SQ1TV is "to promote positive attitudes toward, and enthusiasm for, mathematics." To address this goal, the SQ1TV staff attempted to create a series that would be fun for children and, judging from the comments of the children in this sample, they were successful. Given the difficulty that mathematics poses for many children, it is

important for them to encounter it in a setting that they find enjoyable. While children were taken with the dialogue, jokes, or tricks because they genuinely found them funny, virtually all of the children also recognized the series' educational nature, as we shall see in the next chapter.

CHAPTER 4

SQUARE ONE TV AND EDUCATION

Introduction

Children were clear about their perceptions of SQ1TV as educational. Their ideas about the educational nature of SQ1TV deserve investigation, and for that we will turn to an examination of three subthemes. The first subtheme focuses on the educational purpose of SQ1TV, that it is a series designed to teach mathematics. Included in this is the important message that many children took away from the series: that learning mathematics can be fun. The second subtheme focuses on pedagogy, that is, how mathematics is presented on SQ1TV. Through SQ1TV, children noted the different ways in which one can learn mathematics and that different methods can be employed to arrive at the same answer. In this way, they described SQ1TV as both similar to and different from the ways in which they learned mathematics in school. The third subtheme concerns children's reflections on their own learning, including their comments that SQ1TV taught new mathematics and problem-solving concepts and reinforced existing mathematics skills.

Through the children's comments about SQ1TV as educational television we can hear echoes of other themes. The fact that SQ1TV was perceived as educational did not negate its being fun. Our intent here is to explore the kinds of learning children talked about with regard to SQ1TV, and to do that within the context of the other themes that can be heard in their responses.

Educational Purpose

Twenty-two of the 24 children in this study identified SQ1TV as an educational series with a focus on teaching mathematics. Even the two children who did not make this

explicit claim referred to the mathematical content of the series. Moreover, many children found this mathematics focus to be exciting and a source of fun for them.

Learning mathematics can be fun. Almost one half (11/24) of the children commented that SQ1TV carried the message that learning mathematics can be fun, a message that made a powerful impression on them.

SQ1TV was seen as premised on the idea that children can be "entertained [while] they'll be learning new things"; children perceived the series as working to dispel the belief that learning mathematics and having fun are mutually exclusive activities. This idea was clearly described by some children, like the one who observed

> It [SQ1TV] is fun, but while you're watching it, you're also taking in stuff and learning. I bet that's what their purpose is, an easy way to learn math...it's fun, you're listening and you're looking at it and you're watching...You're laughing because it's funny...you're also learning how to work it at the same time...you're watching them work it [and] you are -- you learn how to.

A total of six children made this connection between fun and mathematics by commenting on the overall format of SQ1TV. The fun things done on the series are what made mathematics fun. "On a television show, they're trying to make it fun so it will be more interesting to try to learn," explained one child. Another commented that she was inspired by SQ1TV to do fractions "by making them fun, like maybe by drawing funny faces on the numbers...like on the number 9." While the series didn't teach her to "draw funny faces on the numbers," she said that SQ1TV did "[teach] me more about fractions than I knew." Part of what she learned was that there are ways to make learning mathematics fun. As one child explained, "It's a 'Sesame Street,' but for older kids" in that education is made enjoyable.

Another five children explained that the experience of learning mathematics and having fun was not limited to SQ1TV itself, but could be played out in places beyond the series. One child noted that SQ1TV

> want[s] you to learn math and to think that math isn't just something to learn. It can, it can be fun too... Some people, they just think "Oh, math, it's just --

> just there for us to learn, not nothing fun." But, it's like the way they [SQ1TV] put it, it seems fun...Some of the times, people are saying, "Man, this is dull. I hate math." Well, then, you can really see, well, math isn't just for you to learn. You can play games with it and you can learn from it too.

This child went on to explain how, at home with her younger brother, "[she] tr[ies] to make games up from math," and that she does it on her own for fun.

A second child said that SQ1TV helped her to realize that "math ain't boring to use. You can -- You could use it in a fun way also." She went on to say that she learned

> that math is fun. 'Cause at first, I thought you couldn't use it in a fun way, but then later, when I saw "Square One," I, I got to the hang of it that it's, like, fun -- don't think it's boring. 'Cause I think "Aw, I'll do this work" and everything [and] I found out that you could use it in a fun way and everything.

A third child elaborated upon this idea by saying that SQ1TV "wants you to think that math is really fun...and it's sometimes hard and it's exciting." Moreover,

> it helps me think over that it's fun to do math, not to think it's real boring and stuff...When I watch "Square One," I figured out that math can be fun...and I figured out that sometimes it could be fun in school too.

Because SQ1TV showed that learning mathematics is fun, these children said they came to see that learning mathematics in contexts other than SQ1TV could be fun as well.

Mathematics Pedagogy

Fifteen of the 24 children commented on the pedagogy of SQ1TV or the ways in which the series presents mathematics. Some children observed that SQ1TV offered, in comparison to their schools, different ways to learn mathematics. Some children reflected on seeing different approaches to arrive at the same answer.

Different ways to learn mathematics. More than one half of the children (14/24) noted that the ways in which SQ1TV teaches mathematics were different from the ways they learned mathematics in school. These children pointed out that when learning in school depends primarily upon listening to the teacher, it is not always effective. SQ1TV, they maintained, offered different ways to learn mathematics through viewing and often playing along with

SQ1TV's game shows, sketches, and "Mathnet."

One third of the sample reported that the learning that goes on with SQ1TV is different from that in school because SQ1TV doesn't rely on "math papers" or worksheets, forms of instruction that these children believed were not most helpful in learning mathematics. They spoke of the advantages of learning mathematics through the series because "you had to find that out the mysteries or something...instead of just getting a pencil and paper moving your hand and all the time trying to figure out [on paper]." Another child noted that "school just gives you the problems and you have to learn it." The teacher explains it, "but after that she just gives you work to do and you have to do it by yourself most of the time." These children perceived that working problems out with SQ1TV offered more interaction, and was therefore perceived as more fun.

Besides the opportunity for interaction, some children commented on the important context for mathematics that the series offered. They explained that on SQ1TV, problems were not isolated; instead, they were placed in a larger, meaningful setting. This is different from the ways in which some children reported experiencing mathematics in school. One child explained that "instead of just like telling you how to do it, they [SQ1TV] say 'Do it like this'...Instead of just telling you steps by order, like the teacher does,...they teach you, what like 'Oops!,' what can happen if you don't do it right or on 'Dirk Niblick,' if you don't get it right it'll cheat you off or something." Another child observed that "instead of like coming up to [the teacher] and saying like, 'What's six times six?'...they [SQ1TV] give you math problems but it's in a game." Five children specifically noted that this aspect of SQ1TV made learning mathematics more attractive and easier for them.

Illustrating the importance of context, one child compared the learning of mathematics on SQ1TV to the kind of learning experienced in a kindergarten class. In fifth grade, she said,

> we just do it, right. They teach us and we just do it...They [SQ1TV] start using it in a fun way and everything. 'Cause ya know, kinders [kindergartners], they use them in little stories and all that. But all we have now...we just do it and everything...Sometimes little kinders use math like with little stories and

everything, they teach them how to handle one another. And that's how they do it on "Mathnet."

SQ1TV seemed to offer a context for mathematics that reminded this child of the "little stories" used in kindergarten. As another child explained, in school, "we're not trying to solve mysteries, we're just doing it 'cause we have to." The "Mathnet" mysteries, for example, seemed to provide a context for mathematics that could make it more meaningful and compelling.

Different methods to the same answer. One quarter of the children said that SQ1TV offered them different methods for arriving at answers, alternatives to the methods they already knew. Some children commented on seeing different approaches to solving fractions or percentage problems. One child explained that SQ1TV teaches people that "there's like different ways to do some things. Like, we were subtracting for X and my mom told me one way and the teacher tells me another way...They [SQ1TV] -- they tell you -- like some -- both the ways...so you can figure it, so you can understand it better." For this child, the illustration of different ways to solve problems led to better understanding. Others simply noted that, in contrast to school, SQ1TV often showed calculators being used.

Sometimes the methods seen on SQ1TV were easier and faster than the methods to which the children were accustomed; at other times, they were perceived as "the long way [because] we take the short cut because we automatically know that it's going to be that." Nonetheless, seeing more than one way to solve a problem reinforced the understanding that SQ1TV "might use a different step...but...it's the same [step]": that is, different steps or approaches could be used to solve the same problem.[7] In addition, many children noted that SQ1TV approaches problems and teaches mathematics "[on] our level." SQ1TV "thinks about it in the same way...[and] solves them like a fifth grader...They do it the way we do it."

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[7] Note, however, that while some children explained that different steps could be used to find a solution, no child mentioned that there might be more than one solution to a problem.

Children's Perceptions of Their own Learning

The majority of children (23/24) said that they learned something from SQ1TV. They perceived themselves receiving reinforcement for existing mathematics skills, learning new mathematics and problem-solving concepts, and/or finding applications for their ideas in school. Only one child had no reflections on his own learning.

Reinforcement. Ten children commented explicitly that by reviewing mathematics that they already knew, SQ1TV was reinforcing certain concepts. SQ1TV "was just trying to get your brain to remember the things that you've done already." Another child made the point of saying that with SQ1TV "you can review the things you already know and learn new things," noting in particular that SQ1TV is helpful in reviewing material so that you can learn it better. Two children commented that you have to know some mathematics in order to participate in the solving of a "Mathnet" mystery. In this way, children perceived that SQ1TV uses mathematical content that is already understood and, in applying it in new ways, reinforces concepts for its viewers.

Learning and applying new concepts. Sixteen of the 24 children offered specific examples of mathematical concepts they said they learned on SQ1TV, including common denominators in fractions, various kinds of geometric shapes, calculations with decimals, and multiplication and division with large numbers. Fourteen of these children commented that they were able to apply these concepts to their current work in school or anticipated using them in later grades.[8]

In discussing how SQ1TV could be applied to current schoolwork, one child explained that "[in class] we get worksheets on [powers] and I try to remember what they did on 'Square

[8] As reported in an earlier section (Learning mathematics can be fun), five children talked about how they had applied the understanding that learning math can be fun to their schoolwork in some ways. Two of those children are already included in the tally of 14/24 children reported here. Adding the other three children, we find a total of 17/24 children who found some application of SQ1TV to school, either through the mathematical concepts learned or the understanding that learning mathematics can be fun.

One' and then, sometimes, I...get most of them right and sometimes...a little bit of little -- little bit of them wrong." Another child said that one day in school "we were studying fractions...and then that day when we watched SQ1TV, it had 'Mathman' with fractions." A third child recalled the division mistake made on an "Oops!" sketch when a character neglected to "carry down [the] one." The child said, "I remember problems I did on SQ1TV when she [the teacher] asked me [a division problem], and I didn't have to figure out the answer...I remembered how to do that."

The applications of SQ1TV to schoolwork might be quite specific, as with the child who said

> You might watch an episode of it and see that and then later in school, like a week later, we might be studying something that was on there and we had already seen it on "Square One" so it would be easier for us to do it in math.

SQ1TV could also apply in a more general way, as seen in the comment of one child who reflected on her ability to solve problems:

> Some of the time, when I'm doing my math problems, sometimes I'm, like, wondering, "How do I really know I know the right answers?" I go..."If I do math, I must know -- I must have to know what the problems are. And what the answers are too."

For this child, knowing "what the problems are" as well as "what the answers are" was an activity that was enhanced by what she learned on SQ1TV. A total of 10 children made references to the various ways in which they found that SQ1TV helped them with school.

Seven children talked about how the concepts learned on SQ1TV could prepare viewers for mathematics in later grades.[9] "In 'Square One,' they teach you -- they teach you sixth-grade stuff," one fifth grader noted. Another remarked that if fourth graders watch SQ1TV, "they'll learn the things that we learned in the fifth grade...they could learn about it now. When they are in fifth, it'll be easier." It was generally acknowledged by these children that

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[9] Of the 14 children who talked about applications of concepts learned on SQ1TV, seven commented on their application to work in later grades and 10 spoke of applications in current work. Three children commented both on applications now and in the future.

learning new concepts through SQ1TV would lead to better preparation for mathematics classes in subsequent grades.

Clearly, children's recognition that SQ1TV "tells you different things that...that the teachers in school don't tell you" does not mean that all of the children learned all of the new concepts set forth in SQ1TV. While the majority of the children, as described above, reported that they learned new concepts from SQ1TV, nearly one half (11/24) commented that they did not completely understand some of the new concepts shown on the series.

For many of these children, the "Phoner" segments were difficult to grasp. They understood that "Phoner" used mathematics, because it involved computations, but they were not clear as to how it worked. To their credit, there are no explicit instructions in the "Phoner" segments as to the underlying principles used. While children associated "Phoner" with mathematics, it was perceived by some as a trick because they did not understand the mathematics.

Other children commented that some concepts, which they did not name, were difficult for them. One child explained that "some of it's over our head...They do higher up and like sixth- or seventh-grade stuff that we don't do yet or we haven't done yet." In this case, insufficient background or presentation may have compromised the amount of new knowledge the child could gain or retain. The same was true for the other 10 children as well, who gave examples of forgetting or never understanding some of the new concepts presented on SQ1TV. Given these problems with retaining some of the ideas presented on SQ1TV, it is important to note again that the great majority of the children (23/24) reported learning new concepts and/or having old, often not completely understood ideas reinforced during their viewing of SQ1TV.[10]

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[10] Even the one child who did not report personally learning something from SQ1TV described the program as one that wanted children to "learn about [math] a little more."

Sex and SES

No consistent patterns of differences were found by either sex or SES. Boys and girls identified mathematics as the focus of the series, made similar comments about the ways in which SQ1TV presented mathematics, and were in agreement that this presentation was often different from the ways in which they learned mathematics in school.

Similarly, no differences were observed as a function of SES. Children in both middle- and low-SES groups reported that SQ1TV presents a variety of ways to learn mathematics and that these are often different from the ways mathematics is learned in school. Likewise, both groups spoke of how SQ1TV showed new methods of arriving at answers that were alternatives to the methods they already knew.

SQ1TV was perceived by both SES groups as useful for them in school. The largest differences observed between the groups were that a few more low-SES children talked about how they used SQ1TV in their school mathematics (9 low-SES children vs. 6 middle-SES children), and that of the 11/24 children who said that they had found that learning mathematics can be fun, seven were from the middle-SES group and four were from the low-SES group. What appear to be subtle differences between the groups disappear, though, when these two sets of results are aggregated. Looking across the two issues, we find that a total of eight middle-SES and nine low-SES children made one of these two statements. Thus, there do not appear to have been any meaningful differences between the two groups.

Summary and Relation to SQ1TV Goals

In reflecting upon how and what they learned from SQ1TV, these children identified SQ1TV as an educational program about mathematics, and close to one half of them went on to assert that the series showed them that learning mathematics can be fun. Many children reflected on the ways they were learning mathematics, both on SQ1TV and in school, and commented on the engaging and varied ways in which the series presents mathematics.

Children were also explicit about their own learning, reporting a variety of concepts that were reinforced or newly learned through their viewing of SQ1TV.

These findings about SQ1TV and education fit with the goals of the series. SQ1TV, as Goal I indicates, seeks to promote enthusiasm for mathematics, which may be enhanced as children come to see that learning mathematics is fun. Children's perceptions that there are different ways to learn mathematics and to arrive at solutions are in keeping with Goal II. And, by their reports of the kinds of mathematical concepts that they learned, children's responses are in line with Goal III, which enumerates the variety of mathematical concepts presented on SQ1TV.

CHAPTER 5

SQUARE ONE TV AND PROBLEM SOLVING

Introduction

Children saw SQ1TV and, especially, "Mathnet" as focused on what we would consider problem solving. Their reflections about problem solving included ideas about the nature of problem solving as well as the process of problem solving. In this chapter we will look at these two subthemes in turn.

Children spoke about the problem solving in the context of "Mathnet" and in other SQ1TV formats as well as the work they did on the Problem-Solving Activities (PSAs) in earlier interviews.[11] Their comments about the nature of problem solving indicated that they viewed it as a complex activity involving thinking, the perception of multiple problems, and mathematics as a necessary component, but not the sum total, of problem solving.

Children also spoke about the process of problem solving. Our examination of this subtheme is shaped by the second goal of SQ1TV, where problem solving is conceptualized via four components: (a) problem formulation, (b) problem treatment, (c) problem-solving heuristics, and (d) problem follow-up. Each of the first three dimensions of the process of problem solving

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[11] Recall from Volumes I and II that the PSAs were a range of mathematically rich, nonroutine, problem-solving situations. Each PSA allowed children to demonstrate the problem-solving actions of Goal II and to reach solutions through a variety of approaches. Three sets of PSAs were used, each at a different level of complexity. The least complex problems, PSAs A and A', were combinatorics problems involving circus performers or stripes on a shirt. PSAs B and B' were of medium complexity and involved sorting party guests or price tags into piles that met several conditions. PSAs C and C', the most complex PSAs, asked children to determine what was wrong with a mathematical game and to fix it. These PSAs involved the owner of a game factory, Dr. Game (and were often referred to by the researchers and the children as "the Dr. Game things"). For the purposes of this report, we use, e.g., PSA A* to refer to the pair of PSAs A and A'. Further details on the PSAs may be found in Volume II.

will be considered in children's discussion of the problem solving seen on SQ1TV.[12]

Nature of Problem Solving

Throughout the interview, children talked about the aspects of problem solving that they saw on SQ1TV. "Mathnet" was, for all of these children, the prime example of problem solving and we will focus our attention first on this format. We will then consider the problem solving that children talked about seeing in other SQ1TV formats. The differences that children pointed out between "Mathnet" and non-"Mathnet" problem solving highlight the complexity of the former. Finally, we will hear children's comments comparing the PSAs to the series, which is for them another perspective from which to reflect upon the nature of problem solving in SQ1TV.

"Mathnet"

In a variety of ways, children connected problem solving with "Mathnet." The thoughts of one child are representative of others regarding the goal of the Mathnetters: "to solve problems...It's like you're watching a movie, a mystery movie and they're trying to find something." The mystery angle, where Kate and George search for clues, wrestle with problems, and figure out their cases, is what many of these children saw as problem solving within SQ1TV. The children perceived that within "Mathnet," problem solving consists of multiple steps and is not simply a matter of doing mathematical computations. Children noted the amount of time and thought involved in solving "Mathnet" cases, the variety of leads that must be pursued, and the ways in which pieces of the case fit together.

Thinking. Almost one half of the children (11/24) talked specifically about thinking

[12] The final component, problem follow-up, will not be discussed here, as no children commented on it explicitly. Recall that, as seen in the results presented in Volume II, the children also did not typically engage in problem follow-up while solving problems.

as an essential part of problem solving. Kate and George had to "think for a while," they had to study the problem and "get it into their heads." Problem solving was not described as seeing an obvious solution or immediately perceiving the way to find an answer. Instead, these children noted that it was necessary to think, to take time, and to reflect on how a problem could be solved.

Multiple problems. As the children talked about problem solving in "Mathnet," they noted that it involved working with many problems and not just one. Built into the "Mathnet" format, with its week-long story lines and complex mysteries, is the idea that problem solving involves many steps. Eighteen of the 24 children noted this, often describing the interrelated problems that had to be solved in order to unravel the various mysteries. As one child explained, on "Mathnet" they "thought about the problem and how to solve it." This meant that "they tried other problems when there was a problem they needed to solve." Problem solving was not a one-step operation.

Eight of these 18 children went on to make a finer distinction among the multiple problems found in "Mathnet" stories. The goal in "Mathnet," these children noted, is to figure out the mystery. Doing that involves solving some mathematical problems, yet the mathematics is only a component of the larger problem to be solved. One child described this distinction by explaining that on "Mathnet," "they have to solve problems...to figure out like who like stole something or took it or did something wrong...They have to figure out...math problems to get to the...problem." In thinking about the "Willing Parrot" mystery on "Mathnet," another child noted that when Kate and George

> had to find the bird, they had to solve the problem, like...think that who would want the bird...who would want to take the bird...The tape said to keep listening to the bird and they would find the money...[They had to think] like...who had the bird.

Pondering who would have a motive for stealing the bird is focusing, in the words of the first child, on the "problem."

Mathematics is central. All of the children spoke of how mathematics was central to the

problem solving they saw on SQ1TV. As one child explained, "[On 'Mathnet'] they use math to find out cases or problems...They use math on finding out -- finding some treasure...They used math almost everywhere they go when they try and find out a problem." Or, as another child expressed it, "Mathnet" is "all mystery and math mixed together...There's mystery that they have to solve, and then they use mathematics to solve it." In noting that there are different kinds of problem solving, a third child observed that "Mathnet" is "well, what I call problem solving...with numbers...The whole 'Mathnet' show is, I think, is a problem solve -- problem solving...because they're working out stuff and it has to do with math and it's it's like a mystery show but it's a big math problem."

Again we see the distinctions children made between mathematics and problem solving: While mathematics was seen as essential for solving "Mathnet" mysteries, not all problem solving necessarily involved mathematics.[13]

Other SQ1TV Formats

Sixteen of the 24 children in this study also identified problem solving with SQ1TV formats other than "Mathnet." Children spoke of the problem solving they saw in "Dirk Niblick," "Backstage with Blackstone," "Mathman," and "Phoner," among others. In describing these segments, children tended to focus almost exclusively on the mathematics in the segments and often on finding the right answer, as opposed to including fairly detailed descriptions of the overall context in which the mathematics was placed (as was the case with "Mathnet"). This seems quite logical, given that these non-"Mathnet" formats presented problems in a simpler context than that seen in "Mathnet."

One child described Mathman as "somebody who has to have a mission and his mission's,

[13] The centrality of mathematics to the problem solving of "Mathnet" foreshadows issues taken up in the next chapter, which explores children's reflections about mathematics in SQ1TV and their own conceptualizations of mathematics.

like, to get the right answer in a math problem." Another child explained that with "Mathman" segments, "you had to put the right numbers that they're asking," giving the example of

> like...t plus five is greater than 15 or something like that and he [Mathman] has to find...the number...to add to five...that's is greater than 15 and and if he doesn't get it right the other one eats, chases him to eat him.

Mathman tries to make his way through the maze before he gets eaten, but to do that he must "get the right answer in a math problem," as noted by the previous child.

In commenting upon how Dirk Niblick demonstrates problem solving, one child explained that "he solves people's problems, like if someone bought something and they charged him more, he went to the store men and he told them that the money wasn't right." Dirk was seen assisting people with their problems, and the focus of the problem solving was in mathematically determining that the "money wasn't right."

These children were all correct in identifying the purpose of these different segments. What is important to bear in mind is that in talking about how Mathman or Dirk or other SQ1TV characters solved problems, children did not represent mathematical problem solving as a rote application of rules or formulas. Instead, they talked about finding the formats "challenging...like you have to use strategy," as one child noted with regard to "Triple Play." While problem solving in non-"Mathnet" segments was shorter, and typically less complex, children still found the segments engaging and talked about how they involved figuring out answers to a variety of mathematical problems.

Problem-Solving Activities (PSAs)

Children were asked to compare the work they did on the Problem-Solving Activities (PSAs) with what was seen on SQ1TV, and to talk about similarities and differences. Posing these questions allowed us to hear whether or not children perceived the PSAs as, indeed, problem-solving activities and, more importantly, provided further insight into their ideas about the nature of problem solving.

Twenty-three children described the PSAs as being similar to what they saw on SQ1TV.[14] In talking about similarities, 16 of these children commented that in both the PSAs and SQ1TV, people have to figure out or solve problems. As one child explained, "[you are] finding out things...I always figure it like in here you figure out like the Dr. Game [PSA C*] and all that and in 'Mathnet' you have to figure out answers to problems and stuff." Another child commented that

> in "Mathnet," they had to figure out the problem, like what was wrong...I had to figure out what was wrong with the game [PSA C*]...They had to find out a way to figure out the problem, like to fix the problem and in the Dr. Game thing I had to tell them um...tell um how they like -- how -- how can we fix the game.

A third child made this same point in saying that

> The Dr. Game stuff [PSA C*] is probably like the treasure [in the "Mathnet" episode "Willing Parrot"]. And they're looking for the treasure. You have to figure out what was wrong and what didn't belong and where the thing was...[Dr. Game] is sort of like a game you're trying to figure out...

In their comments, children focused on the activity of finding out or searching for ways to resolve the problem. Two children did this by comparing themselves to the Mathnetters as they worked on the PSAs. One of them explained that "I tried solving this problem. Now I might be working like the math -- like Monday, and, or Kate and George...because I'm figuring out something, a mystery." The other child said that she asked herself how Kate might solve the problem and then tried to think about it in the same way. A different child noted that this problem-solving endeavor can be hard: "The Dr. Games [PSA C*] are, like, things that you have to study and figure out. It's not just easy. You have to study it and figure it out...like on 'Mathnet,' they had to study, they had to study the things, and they had to figure it out." As another child explained, figuring out the PSAs took some effort: one had to "think to answer the problem."

A total of 12 children commented that the use of mathematics was a similarity between

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[14] In talking about similarities, most children (13) focused on PSA C* ("Dr. Game"), but mention was made of other PSAs as well. Four children mentioned PSA B*, four mentioned PSA A*, and seven made general comments about the PSAs as a whole.

the PSAs and SQ1TV, but only one half of them talked about mathematics in the context of problem solving. The other six children referred to mathematics, especially arithmetic, as something one had to use in both situations, without making any explicit reference to problem solving.

In general, children focused on the problem solving present in both the PSAs and SQ1TV, indicating that the activity of figuring out involves some effort and energy in order to find solutions to problems.[15]

Summary. In describing the problem solving that they saw on "Mathnet," on other SQ1TV formats, and through comparison to the PSAs, children focused on some key attributes. They talked about problem solving as an activity that involves more than one problem, as requiring some thought and effort, and, as seen on SQ1TV, often using mathematics. "Mathnet" was, for the children, a model of complex problem solving. Other formats, such as "Mathman" or "Dirk Niblick," also made use of problem solving, although in a less involved manner. The important point is that mathematics, whether in "Mathnet" or non-"Mathnet" formats, was not perceived by children in a rote or formulaic manner. The problem solving on SQ1TV was characterized, for these children, by the active work of figuring out solutions to problems.

Problem-Solving Processes

We now turn to children's comments concerning the process of problem solving shown on SQ1TV. The nature of SQ1TV problem solving, as described by the children in the previous section, is complex and involves a process. This is in keeping with the second goal of SQ1TV.

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[15] The differences children noted between the PSAs and SQ1TV were superficial in many ways. They said that the details of the PSAs were different from the series' sketches or that certain mathematical concepts were used more widely on the series than in the PSAs. Four children said that they could think of no real differences between SQ1TV and the PSAs.

Problem Formulation

Problem formulation, as described in Goal II of SQ1TV, consists of being able to recognize and state a problem and being able to assess the value and the possibility of solving a problem. In their discussion of the problem solving they saw on SQ1TV, children recognized the ways in which problems were formulated. For example, all children were able to identify and describe the central problem in at least one "Mathnet" episode. Moreover, a large number of children (18/24) commented that many different problems were part of the "Mathnet" stories.

Children viewed Kate and George as working to clarify and target the problems they face. The many children who referred to the "Willing Parrot" episodes, for example, understood that the parrot was central to finding the money left by its deceased owner. The children who described the "Missing Monkey" mystery knew that the key question was determining whether one escaped gorilla could actually commit all the crimes that had occurred within a circumscribed area. Similarly, those children who talked about the "Car Robbery" story perceived that the mystery centered on finding the criminals responsible for stealing cars all over the city.

The majority of children also enumerated some of the other problems that went into each "Mathnet" story. In the "Willing Parrot" mystery, for example, many children listed a number of the different issues the Mathnetters had to face and resolve in order to find the missing money. Thus, children were clear about the central problem of the "Mathnet" mysteries and many of them identified the smaller auxiliary problems as well.

Problem Treatment

A second feature of the problem-solving process used on SQ1TV is the treatment of problems. The aim of the series is to encourage the use and application of strategies such as recalling information or gathering data, among others.

Children described, often in great detail, important information concerning the ways

in which the mysteries were solved, such as using the pattern of bricks in "Willing Parrot," or assessing the area a helicopter could cover in "Missing Baseball." Seven children made specific references to how the Mathnetters gathered data, noting the use of tools such as computers, rulers, compasses, and calculators. Five children specifically spoke about estimation; one child explained that in the "Passing Parade" mystery, Kate and George used this technique to help figure out the route to be taken by the pop singer and his entourage:

> They had to figure out the distance between how many -- okay, the distance between from one point, where they started the parade, to the end, and what time he'd have to be there and how much room that they would have to -- and how much room the people that were going to the parade would take up...They drove by the streets the parade was going to go by. And then they figured out how many miles each one was...and they added up on their blackboard -- they added it up together. And they came up with the total...And they they thought, well, they estimated how many people were going to come and then they they thought that everyone should just get, I think it was a thousand, um, not really that much space for them to sit on.

While this particular child was able to provide a very detailed account of how the Mathnetters treated this problem, almost all of the children related in more or less detail the narratives of different "Mathnet" mysteries (Note that much of this description has been presented earlier).

Problem-Solving Heuristics

A goal of SQ1TV is the portrayal of a variety of problem-solving strategies or heuristics. Four types of heuristics are outlined in the goals of the series: representing problems, transforming problems, looking for patterns or missing information, and reapproaching problems. In their discussions of the series, children offered examples of all four types of heuristics. What is striking is that all but one child talked about at least one type of problem-solving heuristic seen on SQ1TV. Ten children talked about two or more types of heuristics, and an additional 10 talked about three or more.

Fifteen of the 24 children gave examples of the first heuristic, representing a problem. These children identified maps, graphs, charts, or drawings as ways in which the Mathnetters represented the problem at hand.

The second type of heuristic, transforming problems, involved seeing subproblems within the larger problem. As described in the previous section, 18/24 children talked about the fact that a series of problems needed to be solved to figure out a given "Mathnet" mystery.

The third kind of heuristic, looking for patterns or missing information, was described by 15/24 children. A good example of this, and one noted by most of these children, is the Fibonacci sequence, which was a central clue in the "Willing Parrot" story. Children understood and explained how the Mathnetters used this pattern as a strategy for finding the hidden money.

The fourth type of heuristic is reapproaching a problem. Nine children talked about specific strategies observed in "Mathnet" for approaching a problem in a new way. Two children mentioned that Kate and George played the "What If" game, a strategy employed when they had "no more clues to what happened."[16] Other children mentioned tactics such as writing down all the information collected and looking for new angles or clues; "they reread it and reread it." Talking with others was identified as another way to reapproach a problem. Finally, some children perceived the practice of "concentrating," where the Mathnetters "keep thinking about it" as a way of reapproaching a problem and solving a mystery.

Summary

Through their identification of the ways in which problems are formulated, treated, and solved on SQ1TV, children commented on an active process of problem solving. The great majority of children were able to recognize and describe aspects of each of these dimensions of the problem-solving process.

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[16] "What If" is a brainstorming technique used in "Mathnet" in which Kate and George generate and reason through a series of hypotheses.

Sex and SES

In examining this theme of problem solving, no differences were observed with regard to sex; girls and boys appeared to have similar ideas about problem solving vis à vis SQ1TV. Children of middle-SES backgrounds produced a slightly greater number of problem-solving examples than low-SES children did (3.2 vs. 1.9), but they did not differ in their discussions of the nature of the problem solving in those examples; approximately equal numbers of middle-SES and low-SES children talked about thinking and multi-step problems.

Summary and Relation to SQ1TV Goals

Through their comments on both the nature and the process of problem solving, children demonstrated that they were aware of the problem solving emphasized in SQ1TV. "Mathnet," in particular, was a powerful model of problem solving for these children. More than just noticing that problem solving was present in the series, children talked about the active, complex, and thoughtful activity that problem solving can be.

Clearly, the comments of these children are consonant with the second goal of SQ1TV, which is concerned with "encouraging the use and application of problem-solving processes." Children were not only able to talk about the process of problem solving, but were also able to characterize the problem solving on SQ1TV as an activity of figuring out that requires more than the rote application of arithmetic. It is an activity that calls for thought and effort.

CHAPTER 6

SQUARE ONE TV AND MATHEMATICS

Introduction

As noted earlier, children clearly perceived SQ1TV as a series about mathematics. And, as elaborated in the previous chapter, all of the children saw mathematics as necessary for much of the problem solving on SQ1TV. The purpose of this chapter, then, is to explore what the children meant by "mathematics." Three subthemes will be discussed: (a) children's own definitions of mathematics, (b) their perceptions of mathematics in school, and (c) their descriptions of mathematics in SQ1TV. Each of these subthemes will be discussed in turn, and both the connections and the discrepancies between the definitions of mathematics used by the children and by SQ1TV will become apparent.

Children's Own Definitions of Mathematics

Throughout the interviews, we heard children's ideas about mathematics. Early in the interview, children talked about their favorite parts of SQ1TV and explained what those formats had to do with mathematics. As noted in Chapter 2, almost all of the children spoke of "Mathnet" as their favorite part and went on to describe the ways in which Kate and George solved mysteries using various problem-solving heuristics and mathematical content.

After talking about the mathematics on "Mathnet," children were asked the following question: "If you were to ask Kate and George to explain what mathematics is, what do you think they'd say?" Two children were unable to answer the question but 18/24 children hypothesized that the Mathnetters would talk about mathematics as computational arithmetic: as addition, subtraction, multiplication, and division. As discussed in the previous chapter, children described the variety of mathematical problem solving in which the Mathnetters

engage; however, the majority of these children nonetheless agreed with one child's conjecture that Kate and George would say that "math has to do with numbers and, and math facts."

Four children responded that Kate and George would describe mathematics as having something to do with problem solving. Even here, though, their answers were somewhat tentative. One of these children explained that Kate and George would say that it is "numbers and...other concepts and figuring out." Another noted that the Mathnetters would define mathematics as "when you use mathematical stuff to figure out questions and to guess -- not to guess, but -- and to figure out the problems." None of these children made explicit references to various mathematical concepts, but they did manage to link mathematics with problem solving, in contrast to the majority of the children interviewed.

What is intriguing is that while the children could describe Kate and George's problem-solving activities, utilizing various kinds of mathematics, children speculated that the Mathnetters would have a rather conventional view of mathematics as computational arithmetic. While it is true that Kate and George certainly used arithmetic as they worked on their cases, this was not the extent of their mathematical repertoire. That the great majority of children maintained this conception of mathematics as arithmetic attests to the resilience of those ideas for the children. Despite the fact that they saw and identified other mathematical concepts on SQ1TV, when asked directly to talk about a definition of mathematics, they relied on the old standby: mathematics equals arithmetic. [17]

Perceptions of Mathematics in School

The computationally based definition of mathematics described above is the same one that 19/24 children applied to the mathematics that they learn in school. One child explained that Kate and George would say that mathematics is, "like at school, like that's the way it is. What they teach you in school, that's the way math is...They teach you division and

[17] See Chapter 3 of Volume III for a discussion of this issue.

multiplication and addition, subtraction." At many points in the interview, children spoke of "school math" as basic arithmetic. Some children also described other mathematical content studied (e.g., fractions or decimals), but the definition that these children agreed upon for school mathematics was computational arithmetic.

Perhaps this limited definition of mathematics as arithmetic (and, possibly, a few other mathematical concepts) says something about the distinctions the children made between mathematics and other academic subjects. In explaining what SQ1TV is about, one child commented that "it all has to do with math. They don't really have anything like spelling or reading or English or social studies or science...they're mostly numbers." This child's point, echoed by others, was that the distinctive feature of mathematics is that it's "mostly numbers"; the way in which children typically use "mostly numbers" is in basic arithmetic. If the children perceived numbers and arithmetic as the salient features of mathematics in school, this could help explain their reliance upon basic arithmetic as the definition of mathematics. By extension, this perception of school mathematics could have become the basis for their understanding of how Kate and George would define mathematics, despite their appreciation of series' content that extended beyond basic arithmetic.

Descriptions of Mathematics on SQ1TV

While children defined mathematics as consisting of computational arithmetic, arithmetic proved to be only one type of mathematical content that children were able to identify on SQ1TV. An analysis of data from across the interview revealed many instances in which children described a variety of mathematical concepts seen on SQ1TV.

The mathematical content of the series, as described in Goal III, includes geometry, statistics, probability, combinatorics, and numerical functions and relations. Standard topics such as properties of numbers and counting, arithmetic, and measurement also typically appear in problem-solving contexts. (A full elaboration of Goal III is presented in Appendix IV.A.)

The content areas mentioned by the children are listed in Table 6.1. As is clear from the fact that the numbers shown in the table sum to more than 24 (the number of children interviewed), children frequently mentioned more than one content area.

Table 6.1

Number of children mentioning Goal III content areas

Goal III: Mathematical content	Number of children
A. Numbers and Counting (Includes whole numbers, place value, fractions, decimals, negative numbers)	20
B. Arithmetic of Rational Numbers (Includes basic operations, ratios, estimation)	24
C. Measurement (Includes units and spatial measurement)	4
D. Numerical Functions and Relations (Includes inequalities, exponents, equations)	17
E. Combinatorics and Counting Techniques	1
F. Statistics and Probability	1
G. Geometry (Includes tessellations, scale, geometrical objects)	12

On average, the children described four different mathematical concepts apiece (e.g., fractions, decimals, exponents) during their interview. Most children (21/24) talked about concepts in three or more different subgoals (e.g., numbers and counting, arithmetic of rational numbers, and geometry). One child might comment on the fractions, decimals, arithmetic, equations, and geometrical shapes seen on SQ1TV: five different concepts from four distinct subgoals.

Apart from references to arithmetic operations, made by all of the children, the most frequently mentioned subgoal area was numbers and counting (20/24), including fractions (17/24) and decimals (10/24). Geometry (12/24) and numerical functions and relations (17/24), such as inequalities (11/24), were also talked about by many children. The entire array of mathematical concepts that children mentioned was generally linked to specific SQ1TV segments.

Many children associated specific mathematical content with the "Mathman" format. One child noted that Mathman "tries to...find all the pentagons...[or] numbers that are...lower than three." Another child explained that Mathman might be instructed to "eat all the even or odd numbers." A third child commented, "I learned how to...do a little bit of that...[when] Mathman when he was talking about the powers, like seven to the third power."

While "Mathman" was the source of many different mathematical concepts, it was not the only format mentioned. One child explained the type of thing one might learn from a SQ1TV game show:

> They put up a whole stack of cans they put up a ruler to it, they say "How many cans are here?" and they -- and you have to say like "There's twelve cans." And they cover up eight of 'em, that would be, um...two thirds. And you have to try and get the closest fraction.

Cabot and "that little Marshmallow...explain about volume and area and perimeter," and songs contain new mathematical ideas. One child noted that

> there was a song about Roman numerals [where] he said..."I night." That's what it said but it was actually supposed to be "one night" because it was in Roman numeral. And so -- and the singer slowly got mixed up and I don't know how

> many times they stopped it before they finished the whole song, it was something like four or three times. And I didn't quite know much about Roman numerals [before].

Through their references to a variety of mathematical concepts, it is clear that children thought along the lines of one child who said that SQ1TV is "teaching you a whole bunch of things in math." Children did appear to have an awareness of mathematics as containing topics other than just basic arithmetic. Given this, the task of then defining mathematics could be difficult. One child, who was unable to speculate how the Mathnetters would define mathematics, commented that "this is confusing...'cause they've [Kate and George] told different people different things...They tell them different things about math." How is one to define mathematics when it contains a variety of ideas? In presenting different mathematical content in various formats, SQ1TV may have begun to undo the belief that mathematics is only arithmetic. This, however, might have made it difficult for children to explain, with the same conciseness as their old "mathematics equals arithmetic" definition, what exactly mathematics is.

Sex and SES

An examination of the data by sex and SES revealed no differences. Both boys and girls and children of low- and middle-SES backgrounds expressed similar conceptions of mathematics in the context of SQ1TV.

Summary and Relation to SQ1TV Goals

Children appeared to have stable and very resilient definitions of mathematics as computational arithmetic. Yet through SQ1TV and, for some, through school, these children could also understand that there are indeed areas of mathematics other than arithmetic.

One of the goals of SQ1TV is "to present sound mathematical content in an interesting, accessible, and meaningful manner" by exploring a variety of mathematical concepts. It appears that SQ1TV made this mathematical content salient for the children; during the

interview, many of them mentioned a number of different concepts in explicit connection with the series. Thus, SQ1TV provided a context through which children could identify and talk about these "different kinds of math." In this way, SQ1TV may have offered an opportunity for children to develop broader conceptions of mathematics and move beyond their old definition of mathematics as arithmetic.

CHAPTER 7

SQUARE ONE TV AND PARTICIPATION

Introduction

Participation with SQ1TV represents an active involvement, on the part of the children, with the mathematical content presented in the series. Children talked about their participation in SQ1TV in two major ways: First, children commented upon how and why they interacted with various formats during viewing. Second, by reporting conversations and interactions with others after viewing the series, children spoke about a kind of "post-viewing" participation with SQ1TV. Moreover, children indicated that the series encouraged these two forms of participation not only because the series was fun, but also because its mathematical and problem-solving content was challenging and engaging.

Participation While Viewing SQ1TV

Nineteen of the 24 children talked about having participated while viewing SQ1TV. The great majority of their comments focused primarily on three formats: "Mathnet," "Mathman," and the game shows. Children said they found these formats attractive because they sustained their interest and because they were perceived as designed for children their age. Before looking at participation in each of these three formats, let us examine children's comments about SQ1TV, in general, as a series for kids, since these ideas have implications for participation.

SQ1TV is for kids. As described earlier, in Chapter 2, the majority of children (19/24) would recommend SQ1TV to other children because it was for "kids our age." The content of the series was perceived as appropriate to children in or around fifth grade. In addition, a few

children commented that SQ1TV was expressly designed for children. As one child remarked, "It has mostly like kids in it and kid stuff in it, like there's game shows that kids come on." Another child commented that "Mathnet" "portrays kids that have problems." SQ1TV, then, was perceived as a series for and about children, qualities that invited their participation in its various formats.

"Mathnet." The "Mathnet" format, with its continuing story line, engaged the interest of these children. One half of them made reference to the fact that the style of "Mathnet" was engaging, and piqued their curiosity. As one child said, "They like leave you in suspense. When you want to know what something's going to happen, it's just like 'continued' or something. And then when you go...to see it, you want to know what's going to happen. That's why I like it." This sentiment was echoed by another child who said, "They have exciting things that -- you keep on your toes because you want to watch it the next day and it has 'to be continued' and it keeps you hanging. It's exciting in that way."

Eleven of the 24 children talked about participating in "Mathnet" episodes by trying to anticipate the next action or the final solution or by imagining themselves to be one of the Mathnetters. "Mathnet" stories unfold over the course of the week and one child explained that

> [they] give you part of the movie...They'll review from the day before, they'll review that movie and then they'll give you the other part of the movie...And on Thursday you can, like, guess who did it, who did it, and why they did it. And then before Friday even comes, you already know what's going to happen...Or at least you think you know what's going to happen.

Another child commented that "like everybody in our class, they guess when the show ['Mathnet' episode] is over what might happen, happen on the next day and watch it and see who's right."

This practice of anticipating the action of "Mathnet" and trying to figure out the solution to the mystery was noted by a third child who said that "it's always 'to be continued' so you, you always think about what's going to happen next and try to solve it." Solving it, for him, meant

> like figure it out before them, 'cause sometimes they take a little while explaining it to you, but if you know -- we try to beat them...They like tell everything, every way it can happen, and if we know the way, we just do it.

Two of the 11 children who commented on participating in "Mathnet" compared themselves to the Mathnetters. One child explained that "Mathnet" was a favorite because "it makes you feel like you're one of them." The other said

> I'd try to pretend that that was me and what would I do if it was me, of how -- of how to solve the the mystery...When they'd show different scenes, like of the wall of the different squares [referring to the "Willing Parrot" story], I'd pretend like George was me and I'd pretend I would do something certain with the wall or something and I'd make myself believe that I was doing that...Sometimes he was smarter than me and he got the right answer and I didn't...[Another time] I thought to myself before they even said anything, "That's what I'd do" and then they did it...It makes me feel good about myself because I figured it out.

By acting "like George was me," this child participated in "Mathnet" in a very personal way.

"Mathman." Eight children spoke of playing along with "Mathman," either individually or together with classmates. One child explained that while watching "Mathman," "to yourself, you can go 'Go eat so and so, go eat so and so.'[18] Like if he comes to a wrong one, our class 'cause if they come to a wrong one, they'll go -- if he comes to a wrong one we'll all go 'No! No! No! No! No! Go to a different one!'" This scenario is echoed by another child who said that "if it's wrong, everybody'll go 'Wrong! Wrong! Don't eat it!' And then if it's right, they'll go 'Eat it! Eat it!' and stuff...'cause we try to figure out if that's right too...Everybody will start yelling at the TV."

A third child pointed out that he and his classmates interacted with "Mathman" as "if we were the guy, if we were Mathman." This kind of role taking was possible because "[Mathman] waits a while, and it gives you time to say like 'Well, should he eat that or not?' Then you find out if you're right or wrong." Because there really is time to play along, to think of oneself as "that little Mathman guy," these children were able to participate in the "Mathman" format.

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[18] Recall that Mathman's mission is to "eat" numbers that fit certain conditions, and, thereby avoid being devoured by his enemy, Mr. Glitch.

Game shows. Six children talked about participating in the game-show formats by playing along with the show's contestants. In fact, as one child pointed out, "They say you can do it with them." And the children did. One child described participation in the game show "Piece of the Pie" as being "your own team...You can try with them...It's like a third team, you're like a third team." Participation in the various game shows took the form of calling out ideas, thinking of them in one's head, or taking out a piece of paper and writing down answers, "kind of like playing with somebody, but you don't get a reward for it."

"Post-Viewing" Participation

Participation in SQ1TV did not only take place during the 30 minutes in which the children viewed a particular program. Children also commented on ways in which they entered into the activities of SQ1TV by talking about or demonstrating ideas to others after the program was over.

Four children commented that they shared with friends or family something they learned on SQ1TV. One child who liked the "Blackstone" segments said, "I can do [tricks] to my mom. She'll be all freaked out." Later, he explained that he also demonstrated a "Phoner" segment to his mother and "she got real, like, 'How did you do that?'" A second child said that he told his mother how to do "that nine thing [shown in one segment]...that was real fun and it's interesting." The "nine thing," he explained, was "like nine times nine's eighty-one. Eight and one is nine. It's like, everything times nine equals itself. Like, nine times eight's seventy-two, seven and two is nine."

Over half the students (13/24) mentioned that they talked about "Mathnet" or other SQ1TV formats with different people, relating the problems seen, speculating on the next course of action in "Mathnet," or sharing reactions to the games. One child commented that he talked to a friend about "Mathman," "that he shouldn't have did this or shouldn't have did that...He shouldn't have got the wrong number, then he wouldn't have got eaten up." Another

child explained that he talked about "Mathnet" with a friend during physical education class because "like on 'Mathnet,' they keep us hanging, and we like, we walk outside [for P.E.] and we talk and we talk about, 'Oh, no, I think this is going to happen.' And he says, 'No, no, I think this is going to happen.'"

Sex and SES

Almost all of the children in the sample spoke about participation with SQ1TV. No differences were observed with regard to sex; both boys and girls said that they actively took part. An investigation by SES revealed that while middle-SES children produced slightly more examples of participation than low-SES children did (3.0 vs. 1.5), both groups spoke about participating in similar ways (e.g., by working out "Mathman" problems, puzzling over the "Mathnet" cases, or explaining to others what was seen on the series). In addition, they gave similar reasons for their involvement (e.g., the fun of SQ1TV). Thus, the two groups did not seem to differ in any meaningful way.

Summary and Relation to SQ1TV Goals

Participation with SQ1TV took many forms. It could be playing along with a game show, advising "Mathman," anticipating the solution to "Mathnet," or pretending to be a Mathnetter. It could consist of demonstrating tricks to others or telling friends and family about interesting aspects of the series. The majority of children (19/24) talked about their participation during the viewing of SQ1TV. Adding those children who spoke of "post-viewing" participation brings the number to 22 out of 24 children who spoke of some form of participation with SQ1TV. Only two children made no mention at all of ways in which they participated in or were engaged by the series. Most children perceived SQ1TV as a series for children, one that was both fun and had engaging content. In these ways, the series appeared to invite their participation.

Comments by the children about their participation indicate that SQITV can enhance children's development of "positive attitudes toward, and enthusiasm for, mathematics" (Goal 1). More specifically, the series is intended to promote the idea that "mathematics can be understood, used, and even invented, by non-specialists." These children, clearly non-specialists, were not only viewing mathematics, but doing mathematics. Exposure to the series stimulated them to actively engage in mathematical problem solving, both during and after viewing.

CHAPTER 8

SQUARE ONE TV AND APPLICATIONS OF MATHEMATICS AND PROBLEM SOLVING

Introduction

In this chapter we examine the specific examples of applications of mathematics that children talked about in their interviews. The subthemes are clustered under two different levels of applications, which will be the focus of this chapter. The first level contains children's descriptions of SQ1TV characters' applying mathematics or problem solving in their SQ1TV lives. Included is a discussion of the children's perceptions of the ways Kate and George of "Mathnet" feel about and use mathematics. This level of application is situated in the actions and scenarios of the series itself.

With the second level of application, children moved beyond examples applied within SQ1TV. In this level, children made references to SQ1TV formats or to the series generally, but the examples of mathematics or problem solving were located in the "real world," the world beyond SQ1TV. By exploring these various applications we develop an understanding of how children appeared to generalize from the series. At the same time, these examples point to issues of further inquiry, including the extent to which children perceived SQ1TV as being realistic and therefore open to generalization and application beyond the series.

Applications by SQ1TV Characters

Throughout the interviews, children described numerous examples of how characters on SQ1TV applied or used mathematics and/or problem solving in their lives or actions on the series. We will begin with a review of the kinds of examples children offered about how various SQ1TV characters used mathematics and/or problem solving. Because much of the

children's focus was placed on "Mathnet," we will then turn our attention to children's extended discussions of Kate and George's applications of mathematics. Their comments contain information about the varied uses of mathematics by the Mathnetters as well as ideas about Kate and George's feelings about that use.

Applications in non-"Mathnet" Formats

In their descriptions of problem solving, many children talked about how SQ1TV characters used mathematics and/or problem solving in various segments. Prominent among the formats children discussed were "Dirk Niblick," "Oops!," and "Mathman." The comments of the following three children are typical of those offered by others.

One child noted that in "Dirk Niblick" sketches "people call him to...to solve a problem" and that "he uses math all the time," giving a particular segment as an example. Dirk's mother called him up, explaining that her lights were out and wondering how many socks she would have to remove from her drawer in order to make a pair. Using mathematics, Dirk was able to tell her. In "Oops!," a second child explained, serious things happen if mathematical mistakes are made. In one segment, incorrect multiplication meant that "like a building falls down if they do that mistake." And a third child commented that Mathman uses mathematics such as fractions or in problems [where] "blank plus blank equals less than...25." By "eating" only the numbers that satisfy the inequality, Mathman can win.

Applications by Kate and George

All of the children talked about the ways in which Kate and George of "Mathnet" use mathematics and/or problem solving in their work, many examples of which have been presented in earlier chapters. We were also interested, though, in inquiring more specifically about the children's perceptions of Kate and George's feelings regarding their use of mathematics given that the two are principal characters in the series. Thus, we asked the

children, "How do you think Kate and George feel about math?" Almost all of the children (22/23)[19] described the Mathnetters as liking mathematics and as being happy about their ability to use mathematics, connecting their feelings with their applications of mathematics.

Use of mathematics. As discussed in Chapter 5, all the children talked about Kate and George's use of specific mathematical concepts in a variety of "Mathnet" stories. Rather than repeating that information, we now focus on the more general ways in which children talked about Kate and George using mathematics. All of the children described the Mathnetters' use of mathematics in ways that emphasized its importance to them.

One child explained that Kate and George "have to study it [mathematics] a lot and have to know -- they have to know with their job, how to work it, how -- like a bunch of -- like, math has a bunch of...things to it...and they probably have to know a bunch of all that to -- 'cause of their job. It deals with a lot of math." This child went on to note that Kate and George feel that mathematics is "sometimes fun and sometimes you have to use it seriously to to figure out something that you're wanting to know."

Some children perceived Kate and George as using mathematics for things other than their everyday crime work. One child commented that the Mathnetters enjoyed mathematics

> because they use it when they're solving a crime and everything and when they're not solving a crime...when Kate was working on her work, paperwork, and George was carving out a train...like [what] a real train would look like...He had to make sure that it's the right right inches, how long it's really supposed to be, how thick and stuff.

Feelings about mathematics. The children viewed Kate and George as having a very positive attitude toward mathematics, reinforced by their ability to use it successfully. Kate and George "like it because...they use math to find out things...They use it a lot and they're -- they look interested in it. That's how I found [that] they like it." Besides being interested in mathematics, other children remarked that the Mathnetters feel excited, happy, or proud about

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[19] One child was not asked this particular interview question and there are no other data about his perceptions of Kate and George's feelings about mathematics.

their use of mathematics. One child commented that Kate and George

> feel exciting every time it's dealing with math...[George]'ll go, "I'll figure that one out", then he'll say, "I'll figure that...other one out" and stuff. 'Cause they would think it's exciting every time it comes to math...They would [say] like, "Oh, I want to do this one" and they'll say "I'll do it," like that, and they'll get their calculator out and start doing it. And they sound happy. At least they won't go, "[Sigh], OK, let's see now." They'll just think it's exciting.

In response to the interviewer's request for more information about what makes them feel excited, the child continued,

> I guess it's because the mathematicians...have to do that problem to solve the case...[It would] be fun, I guess, for them because it comes out to the answer to solve the problem. And that's how you'll figure out the show ["Mathnet" story]. And they like solving 'cause...after the whole week, and they figured out the whole problem, then they'll feel excited about it and they'll jump and they'll go like that [slap hands together in the air].

Another child explained that the Mathnetters like mathematics "'cause they probably like...finding things, helping people and using math." This child went on to mention other reasons why Kate and George like math: "They just like it for entertainment. They just like it 'cause it's fun on their job. They get to go places and do things interesting." Using mathematics, noted another child, made the Mathnetters "feel happy...'cause they probably like...doing math problems...'cause they're always using math on the problems that...they have on Mathnet." A fourth child described Kate and George as feeling happy about their use of mathematics in their job because "it helps them...they figure out their problems." This child conjectured that the Mathnetters chose this job because "they thought it would be exciting. Probably [they] thought that'd be exciting for them to learn about math." Because Kate and George "were good at math, and they liked math," a fifth child concluded that they would feel proud when they solved problems.

Finally, one child viewed mathematics as integral to both the work and the identity of the Mathnetters, in the same way that a particular piece is integral to a puzzle.

> They like it a lot [because] they are always using it. [They feel that] math helps them...it's like a piece that belongs to them...Like, you know the puzzle? If you don't have all the parts that would make a whole [puzzle], it's like if George and Kate were missing like a piece, and this one's math and this one's them and and

then they, they put in, they put it in the right space. And it [mathematics], like, helps them, more better.

For this child, mathematics was perceived not only as helpful to Kate and George's work but as vital to their sense of who they are.

Clearly, children perceived Kate and George's use of mathematics as intimately tied to their positive feelings about it. The Mathnetters were seen as successful in their work, as using mathematics well, and as feeling good about what they do. Given these perceptions, SQ1TV characters such as Kate and George seem to have the potential to be powerful role models for children.

Applications Beyond the SQ1TV Context

Children also talked about ways in which the mathematics and problem solving of SQ1TV had applications beyond the lives and actions of particular characters on the series. There are two ways in which to think of these kinds of applications. One way, applications of SQ1TV to school, has been discussed in Chapter 4. As the reader may recall, 14/24 children talked about how mathematical concepts learned on SQ1TV had applications to their schoolwork. An additional three children commented that learning that mathematics can be fun had an impact on their schoolwork. Thus, within an educational context, 17/24 children described some application of SQ1TV in their lives.

The second way in which to speak of applications of SQ1TV beyond the lives of the series' characters, and the focus of this section, is to discuss examples of application that are not school-based. A total of 18/24 children gave these kinds of examples, with one half of the children offering two or more different examples. For the purpose of discussion, it is helpful to divide these examples of applications of mathematics and/or problem solving into three groups: (a) examples of direct transfer from the series to real life, without changing any distinguishing features of the segment, (b) examples of extrapolation from the series to real

life, with reference made to a particular segment, and (c) examples of links between SQ1TV and mathematics in the world in general, without explicit reference to a particular segment.

Applications Transferred Directly from SQ1TV

Fourteen children gave examples of applications of mathematics and/or problem solving from SQ1TV, but stuck very close to the scenario of the particular SQ1TV segment from which it was drawn. Two children, for example, commented that Dirk Niblick used mathematics to prevent others from being cheated out of their money. The applications they described were very similar, in that the child saw him or herself in the role of Dirk Niblick. One of these children explained "like if I was an engineer or something, selling things, or a salesman...They could cheat me off or something. And if I didn't add or something wrong, they -- I could cheat like myself off." The other child noted that, just like Dirk, "if I was to go to a store and they would give me the wrong amount of money, that way I could count an -- count it and go back and tell them that they gave me the right -- the wrong amount of money."

Other children focused on the ways in which they could take on the problem-solving role of the Mathnetters. One child commented that, as in "Mathnet,"

> when somebody would take something of mine, that I needed...that...like...I could try and find out who it was that took it 'cause someone would probably show that they want it, they wanted it uh very much...It would give me a clue to who wanted it.

"Oops!," a sketch that dramatizes what happens if mistakes are overlooked, was seen by others as having application to "real life." One child explained "in their job, like if they're an architect and they're doing that [making a mistake], and then they build a building and it falls down."

Applications Extrapolated from SQ1TV

Seven children gave examples of applications that were extrapolated from the series,

that is, applications that were based on a particular SQ1TV segment but changed somewhat to fit a "real-life" situation. With this kind of application, the children referred to a mathematics concept or problem-solving heuristic seen in a SQ1TV segment, but set his or her application in a new context. For one child, the combinations seen on a "Superguy" segment[20] suggested an example. He talked about the combinations possible in toy selection, explaining that "I was trying to see how many selections of things I could have, like how many toy Micro Machines I could have and how many cars and how many toy Micro Machine boats you could have...Well, find out the selection."

For most of these seven children, "Mathnet" proved to be a good source of ideas to extrapolate to new situations. Three children explained that police in search of real criminals solve problems like the Mathnetters. Two children talked about identifying with the Mathnetters as they worked on the PSAs in earlier interviews. The problem-solving activity of "Mathnet" had, for these children, applications to different settings.

Applications Linked to SQ1TV

The third group of application examples are those in which children made links between SQ1TV and the mathematics that they see or use in the larger world; with these applications, children did not make reference to a particular segment, but talked in general terms about applications of ideas from SQ1TV.[21] Although the links between SQ1TV and their examples were not always made explicit, the examples arose in a discussion about SQ1TV and were very consistent with the mathematics and/or problem solving they described seeing on the series. A total of 11 children talked about this type of application, with eight of them offering

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[20] This segment consists of Superguy's attempting to figure out how many combinations of capes and belts he could make given three belts and three capes.

[21] For one half of these children, two particular interview questions proved useful in helping them talk about applications: "Do you think it's important for you to know about those ways for figuring out [that you saw on SQ1TV]?" (Question 23) and "What do you think the people who make SQ1TV want you to learn or to think about?" (Question 12).

examples that focused on jobs, two giving money management examples, and one giving both.

In describing a job-related application linked to SQ1TV, one child commented that "in case you grew up to be somebody that -- that has to use a lot of math, they [employers] might not want you to get the job and then get fired 'cause you don't know math." Another child explained that "[if you know ways of problem solving] it'd make it easier in life if you knew how to work it...if you have a job [and] if you knew how to do these things [i.e., problem solving], you wouldn't have to have somebody explain it to you." A third child explained that

> You could use it [mathematics] for work...You can work at an office or something and you probably sell goods to other countries. And you have to find how much goods to sell, 'cause you can't sell just all of them. You might need some for the other country...if you want two countries to have the same, you have to divide or multiply or subtract.

Or, as a fourth child remarked, mathematics is necessary

> if your mom or somebody works with Avon or something and they have to know how to write the numbers down and add them and plus 'em and stuff like that, instead of taking long and counting them...They already know how much taxes to pay and all that.

Only one child spoke about her own future career:

> When I get older, I'll probably need the math for what I'm gonna do when I grow up...I'm gonna be a photographer, and the other one's kind of -- weird: a surfer...I have to know what kind of film the camera uses by what sizes and things and if I'm going to make a surfboard to surf on I'd have to know the height and the width and everything.

All of these children who described the importance of mathematics and/or problem solving for future jobs did so in the context of talking about SQ1TV. While the specific links between the series and its applications were not always clear, it appears that the children found some connections.

The same held true among the three children who talked about examples of money management as applications. One child commented that SQ1TV wanted you to think about mathematics for "paying bills and stuff like that or buying a car...like if you get $2000 a week or something, you can see how many weeks it's going to take." Another child explained that

> [you'll probably use math a lot] when you grow up and when you're...going to the grocery store or when you're going to buy a car or something. When you go to a grocery store you need to learn math because you might just have to a...a little bit of money and you need to just buy the things you need, so that way you could have enough money.

These children maintained that the mathematics involved in money management, linked to SQ1TV, has application in the "real world."

Applications of SQ1TV and "Realness"

As seen, children talked about applications of SQ1TV in a variety of ways. For five children, the issue of application seemed to generate discussion about the "realness" of the series. In essence, the children asked whether the mathematics and problem solving seen on SQ1TV were real, i.e., whether they were like what one would use in one's own life.

Two children talked specifically about the ways in which they found SQ1TV to be realistic. One child commented that "real people come on [SQ1TV], real people are using math. I'm a real person too." He went on to explain that he used his brain to figure out SQ1TV problems as well as the PSAs; therefore, they were both real problems. Another child, referring to a line from the opening of "Mathnet," commented that "the problems are real...The characters are actually made up but...it kind of tells about their lives...The problems have really happened." He went on to explain that although Kate and George may be made-up characters, they are like real police officers, and "I'm sure they have to do the same process." The reality of the problems contained in the scenarios outweighed the patently made-up characters seen on the series; for these children, the "realness" of SQ1TV did not appear to be an issue.

Three other children did, however, express some reservations about the "realness" of the series.[22] One child said that "[SQ1TV] is just like a game show. It's not really how you use math in your life...[On 'Mathnet'] they walk around with calculators, using calculators for

[22] Despite their comments about the lack of realness of the program, two of these children did talk about applications of SQ1TV in the world at large.

everything and I mean I don't think there's really detectives that use ma -- that figure out just things that have to do with math...It sort of seems fake." In describing the jobs on "Mathnet," one child expressed some ambivalence about whether such jobs could really exist; she said, "You might get the job one day. Well, how can you get the job? There's probably no such job. You could probably have something to do like that." These two children pointed out ways in which the characters or action on SQ1TV seemed unrealistic, while a third child commented that the work sheets or story problems he does in school bear little resemblance to the work done on SQ1TV. He went on to say that "if I have to solve something, it's never -- sometimes it's not a pattern to solve," as on "Mathnet."

The comments of the last three children raise questions about the ease with which some children can come up with applications of SQ1TV. As children have stated repeatedly in the interview, and as reported in Chapter 3, part of what makes SQ1TV attractive are the outlandish sketches, the humorous incidents, and the funny details, like Kate and George pulling out their calculators instead of guns. Yet, these are some of the features identified by these children as limiting the applicability of the series to "real life." The literal level at which these few children viewed SQ1TV may mean that for them, the series in some ways inadvertently undercut its purpose. While children did perceive and appreciate the difference between what was made up and what was real, the unrealistic elements of the series may have made it difficult for some children to identify realistic applications of SQ1TV.

Sex and SES

An analysis of the children's responses by sex revealed no differences. Girls and boys offered similar examples of applications of mathematics from SQ1TV.

An analysis by SES revealed that approximately equal numbers of middle- and low-SES children gave examples of mathematics (6 vs. 5), although middle-SES children offered somewhat more examples of applications than low-SES children did (11 vs. 7). However, the

nature of these examples was very similar across the two groups. The two most popular types of applications of SQ1TV were money management and job-related, and both middle- and low-SES children gave examples of each. Thus, although more application examples were given by middle-SES children, the substance of the applications offered by the two groups was largely the same.

It is also noteworthy that, as we discovered in examining children's perceptions of the characters' feelings, none of the children made reference to the sex, ethnicity, or SES of the characters shown on SQ1TV. The fact that the Mathnetters were a woman and a man or that characters of different ethnicities or socioeconomic backgrounds worked to solve problems on the series was not explicitly commented upon by the children. While three children did talk about identifying with SQ1TV characters of the same sex, it is unclear whether sex was a salient feature for this identification; moreover, the ethnicity of the character did not always match that of the child. In general, then, children appeared to talk about SQ1TV characters without regard to their sex, ethnicity, or SES.

Summary and Relation to SQ1TV Goals

The great majority of children talked about ways in which they saw applications of SQ1TV. All of the children found applications of SQ1TV in the lives of the characters, such as Dirk Niblick, Mathman, or Kate and George. The "Mathnet" examples were particularly powerful because, here, the children talked about the application of mathematics linked to positive feelings about mathematics. Children described Kate and George as being happy and successful in their use of mathematics.

When consideration was given to examples of application beyond the lives of SQ1TV characters, children again offered numerous examples. If the examples of SQ1TV application within education (17/24) are aggregated with the examples of SQ1TV application in life beyond school (18/24), we see that a total of 22/24 children commented on some kind of

application of SQ1TV.[23] Thus, while a few children raised questions about the "realness" of the series' scenarios, almost all of the children were able to talk, in various ways, about applications of the mathematics and problem solving of SQ1TV in the world beyond the series.

The findings presented in this chapter on applications have relevance for all three goals of SQ1TV. The fact that children were able to talk about how the mathematics of SQ1TV can be used in other situations is consonant with Goal 1A: "Mathematics is a powerful and widely applicable tool useful to solve problems, to illustrate concepts, and to increase efficiency." Moreover, children were able to cite applications of different mathematical and problem-solving concepts, an activity relevant to both Goals II and III. While the hope is that children will be able to draw ever larger generalizations from the series to their own lives, it is important to appreciate the many ways in which these children already found applications of SQ1TV.

[23] The two children who did not offer specific examples of application beyond the context of SQ1TV did give examples of the use of mathematics and problem solving by SQ1TV characters and also would recommend the series to others as one from which they could learn mathematics.

CHAPTER 9

CONCLUSIONS

After viewing 30 programs of SQ1TV, viewers had many things to say about the series, and the majority of their comments were quite positive. We will now consider each of the themes that emerged from their responses in turn.

Fun

Throughout the interview, children talked about the fun of SQ1TV. Most of them commented on the humor of the dialogue and the actions of the characters. Many talked about the entertainment value of the series or the ways in which it provided a change of pace from their everyday schoolwork. Children, through their responses, showed that they could distinguish between the fun and amusing forms of SQ1TV, its sketches, songs, and serials, and its overarching mathematical content. While they enjoyed SQ1TV, they also appreciated its mathematical mission.

Education

SQ1TV was, for many of these children, a vehicle for reflecting on the many ways in which mathematics could be learned. Children noted the differences and similarities between the presentation of mathematics on the series and in their own classrooms. The interaction with SQ1TV and the contexts provided by the series supported learning mathematics. Children's engagement with the series seemed to lead to greater possibilities in their own learning, particularly the perception that learning mathematics can be fun. Even those children who did not specifically make this claim seemed to affirm that learning was possible and enjoyable through SQ1TV.

Problem Solving

Children talked a great deal about the problem solving they saw in many of SQ1TV's formats, particularly "Mathnet." "Mathnet" offered a model of complex problem solving that many children talked about, noting the thinking involved, the presence of multiple problems, and the strong mathematical emphasis found in the stories. Children commented on the nature of problem solving as an activity that calls for effort and thought. Children also recognized a process in the problem solving seen on SQ1TV, identifying ways of formulating and treating problems. They described many different problem-solving heuristics that were used.

Mathematics

In their descriptions of problem solving and their discussion of the mathematical focus of the series, children identified a variety of mathematical concepts. Nonetheless, when asked for a definition of mathematics, they provided a conventional definition of mathematics as computational arithmetic. While the children were accurate in pointing out the places in the series where arithmetic was presented, their equating mathematics with arithmetic reflected, for many, their own perceptions of elementary-school mathematics. This view of mathematics as computational arithmetic was a resilient idea, existing even in the face of numerous examples of other mathematical concepts that children were able to identify in the series.

Participation

Children did not watch SQ1TV passively, but rather spoke of the many opportunities that they found to participate in the series. Children referred to playing along with game shows, working to solve "Mathnet" mysteries, and demonstrating ideas learned on the series to friends and family, as well as talking with others about what they had seen. Only two children in this study did not talk at all about the ways in which they participated in or were engaged by SQ1TV. The rest seemed to agree that the problem-solving and mathematical content of

SQ1TV invited their participation.

Applications

Throughout the interview, children talked about the many possible applications of ideas from SQ1TV. Many of them commented on the fact that they had applied, or anticipated applying, mathematical concepts from the series to their school mathematics. The characters on SQ1TV were cited by all of the children as demonstrating many different ways to use mathematics, with Kate and George as the best examples. Children talked about the Mathnetters as both successful and happy in their application of mathematics and problem solving in the mysteries they face every week. Many of the children were also able to describe ways in which the ideas of SQ1TV could be applied in the "real world," moving from the examples they saw on the series to ones they saw in the world around them.

Sex and SES

While much of the discussion of this volume has focused on the responses of all 24 viewers in this study as a whole, it is important to consider whether any differences existed between the subgroups that made up this group of viewers. No differences were found in the children's responses as a function of their sex. In addition, while a few differences were found between children from low- and middle-SES backgrounds, these differences were very small and concerned only the number of examples that the children offered, not the substance of those examples. Thus, there do not appear to be any substantive differences in these data as related to either sex or SES.

Conclusion

Woven through all of the themes presented above are children's perceptions of SQ1TV as fun and about mathematics. They enjoyed the various formats of the series and they found

engaging opportunities to participate. They were clear in their recommendations of the series to other children. At the same time, they felt that they learned mathematics from the series. They talked about the variety of mathematical concepts seen on SQ1TV and the different ways in which these were presented.

Moreover, having fun and learning mathematics were not seen as incompatible activities. All of the children agreed that SQ1TV was devoted to both of these aims. Furthermore, one half of the children went beyond this to say that, through SQ1TV, they came to see that learning and doing mathematics was fun. One child explained that SQ1TV "wants you to think that math is really fun...and it's sometimes hard and it's exciting... It helps me think over that it's fun to do math, not to think it's real boring and stuff." Other children echoed this claim, that SQ1TV helped them see that having fun and learning mathematics are not unrelated, and indeed, that one could have fun learning mathematics.

Such perceptions are quite consonant with the desire of proponents of reform in mathematics education that children come to see mathematics in a positive way (e.g., NCTM, 1989). Taken with our results concerning participation, these findings suggest that SQ1TV provides a context that can encourage not only positive perceptions of mathematics, but also the active doing of mathematics.

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APPENDIX IV.A:

Goals of **SQUARE ONE TV**

ELABORATION OF GOALS OF SQUARE ONE TV

GOAL I. To promote positive attitudes toward, and enthusiasm for, mathematics by showing:

A. Mathematics is a powerful and widely applicable tool useful to solve problems, to illustrate concepts, and to increase efficiency.

B. Mathematics is beautiful and aesthetically pleasing.

C. Mathematics can be understood, used, and even invented, by non-specialists.

GOAL II. To encourage the use and application of problem-solving processes by modeling:

A. Problem Formulation

1. Recognize and state a problem.

2. Assess the value of solving a problem.

3. Assess the possibility of solving a problem.

B. Problem Treatment

1. Recall information.

2. Estimate or approximate.

3. Measure, gather data or check resources.

4. Calculate or manipulate (mentally or physically).

5. Consider probabilities.

6. Use trial-and-error or guess-and-check.

C. Problem-Solving Heuristics

1. Represent problem: scale model, drawing, map; picture; diagram, gadget; table, chart; graph; use object, act out.

2. Transform problem: reword, clarify; simplify; find subgoals, subproblems, work backwards.

3. Look for: patterns; missing information; distinctions in kind of information (pertinent or extraneous).

4. Reapproach problem: change point of view, reevaluate assumptions; generate new hypotheses.

D. Problem Follow-up

1. Discuss reasonableness of results and precision of results.

2. Look for alternative solutions.

3. Look for alternative ways to solve.

4. Look for, or extend to, related problems.

GOAL III. To present sound mathematical content in an interesting, accessible, and meaningful manner by exploring:

A. Numbers and Counting

1. Whole numbers.

2. Numeration: role and meaning of digits in whole numbers (place value); Roman numerals; palindromes; other bases.

3. Rational numbers: interpretations of fractions as numbers, ratios, parts of a whole or of a set.

4. Decimal notation: role and meaning of digits in decimal numeration.

5. Percents: uses; link to decimals and fractions.

6. Negative numbers: uses; relation to subtraction.

B. Arithmetic of Rational Numbers

1. Basic operations: addition, subtraction, division, multiplication, exponentiation; when and how to use operations.

2. Structure: primes, factors, and multiples.

3. Number theory: modular arithmetic (including parity); Diophantine equations; Fibonacci sequence; Pascal's triangle.

4. Approximation: rounding; bounds; approximate calculation; interpolation and extrapolation; estimation.

5. Ratios: use of ratios, rates, and proportions; relation to division; golden section.

C. Measurement

1. Units: systems (English, metric, non-standard); importance of standard units.

2. Spatial: length, area, volume, perimeter, and surface area.

3. Approximate nature: exact versus approximate, i.e., counting versus measuring; calculation with approximations; margin of error; propagation of error; estimation.

4. Additivity.

D. Numerical Functions and Relations

1. Relations: order, inequalities, subset relations, additivity, infinite sets.

2. Functions: linear, quadratic, exponential; rules, patterns.

3. Equations: solution techniques (e.g., manipulation, guess-and-test); missing addend and factor; relation to construction of numbers.

4. Formulas: interpretation and evaluation; algebra as generalized arithmetic.

E. Combinatorics and Counting Techniques

1. Multiplication principle and decomposition.

2. Pigeonhole principle.

3. Systematic enumeration of cases.

F. Statistics and Probability

1. Basic quantification: counting; representation by rational numbers.

2. Derived measures: average, median, range.

3. Concepts: independence, correlation; "Law of Averages."

4. Prediction: relation to probability.

5. Data processing: collection and analysis.

6. Data presentation: graphs, charts, tables; construction and interpretation.

G. Geometry

1. Dimensionality: one, two, three, and four dimensions.

2. Rigid transformations: transformations in two and three dimensions; rotations, reflections, and translations; symmetry.

3. Tessellations: covering the plane and bounded regions; kaleidoscopes; role of symmetry; other surfaces.

4. Maps and models in scale: application of ratios.

5. Perspective: rudiments of drawing in perspective; representation of three-dimensional objects in two dimensions.

6. Geometrical objects: recognition; relations among; constructions; patterns.

7. Topological mappings and properties: invariants.

APPENDIX IV.B:

Description of Sample **SQUARE ONE TV** Program

Description of Sample **SQUARE ONE TV** Program (Show Number 101)

Note: The listing here describes the order in which segments were seen. All segments, with the exception of bumpers (short segues between segments), are listed. The type of segment (song, animation, etc.) is found in the parentheses.

Infinity (song)
The song introduces the idea that there is no largest number. The graphics suggest that there is no largest collection to support the song.

Mathman: Multiples of 3 (animation)
Mathman plays a video game in which he must eat only multiples of 3.

Phoner: The answer is 3 (studio sketch)
Arthur has a one-sided telephone conversation in which he chooses a number and performs a series of operations that always gives him the answer of 3.

Battle of the Bulge Caterers: Sandwiches (studio sketch)
The Battle of the Bulge Catering Company must make more than 11 different sandwich combinations from two meats and three cheeses. The problem introduces the multiplication principle from combinatorics.

Oops! Subtraction 300 - 163 (studio sketch)
A confused engineer makes a borrowing mistake in a subtraction problem and causes a stock-footage plane crash.

Perfect Squares (song)
A blues band sings about square numbers and graphically suggests their connection to geometry.

Bureau of Missing Numbers: 14 (studio sketch)
Terry Ryan, an FBI type, takes information pertaining to the number 14 and inputs this information into her computer. These characteristics include factors, whether it is prime or square, etc.

Mathnet - Problem of the Missing Monkey #1
The Mathnetters investigate a series of burglaries allegedly committed by a monkey that escaped from the zoo.

APPENDIX IV.C:

SQUARE ONE TV Interview Protocol

SQUARE ONE TV INTERVIEW

This interview is going to be a little different than the ones we've done because today I'd like to talk to you about SQUARE ONE TV. I understand you've been watching the show in school for the past couple of months. I am very interested in finding out what you think about SQUARE ONE TV, so I'll be asking you lots of questions.

1. What do you think about the show? What makes you say that? [Probe for why they like/dislike the show.]

2. If you could choose three words to describe SQUARE ONE TV, what words would they be? [Probe for their choice of words.]

3. Could you explain to me what you think SQUARE ONE TV is about? Can you tell me more about that? [Do not explicitly ask them to explain what math is, if that is their answer to the first of these questions.]

   [If have not mentioned "math":]
   Do you think SQUARE ONE TV has anything to do with math? How/How not?

4. What is your favorite part of SQUARE ONE TV? Why?

5. Can you explain to me what [_____] has to do with math?

   If "Mathnet" not favorite, proceed with Q9.
   If "Mathnet" is favorite, proceed with Q6.

6. Remember Kate and George on "Mathnet?"

7. If you were to ask them to explain what math is, what do you think they'd say?

8. How do you think Kate and George feel about math? Why?

9. What is your second favorite part of SQUARE ONE TV? Why?

10. Can you explain to me what [_____] has to do with math?

    If "Mathnet" is neither favorite nor second favorite, proceed with Q31.
    If "Mathnet" is second favorite, proceed with Q33.

11. Can you think of one particular thing on SQUARE ONE TV that you really liked or really made an impression on you? What was it? What made it special?

12. What do you think the people who make SQUARE ONE TV want you to learn or to think about?

13. How is the math on SQUARE ONE TV different from the math you do in school?

14. How is the math on SQUARE ONE TV like the math you do in school?

15. Can you name one part of SQUARE ONE TV that you really learned something new from? What did you learn? Any other parts? What did you learn from them?

16. Has watching SQUARE ONE TV helped you with anything in school? If so, what?

17. Has watching SQUARE ONE TV helped you with anything outside of school? If so, what?

18. Who should watch SQUARE ONE TV? How come? Anyone else? How come?

19. Did you talk with anyone about SQUARE ONE TV? What did you say?

20. What kinds of problem solving did you see being done on SQUARE ONE TV? Anything else?

21. Do you think it's important for you to know about those ways of problem solving? How come?

Depending on answers to Questions 20 & 21, ask same questions as follows:

22. What kinds of figuring out did you see being done on SQUARE ONE TV? Anything else?

23. Do you think it's important for you to know about those ways of figuring out? How come?

24. Were there any things you saw on SQUARE ONE TV that you never thought were math before you saw them on the show, but now you think, "Yeah, that's math too!" Can you tell me about them? Anything else?

25. Does SQUARE ONE TV show how people use math in their lives? Can you give me some examples? Anything else?

26. How is the math on SQUARE ONE TV like the things that we did with you -- you know, like the Dr. Game things and the other things that we did?

27. How is it different from the things that we did with you?

28. Did you think or talk about SQUARE ONE TV while you were working on the things we gave you or while you were talking to the researcher? If so, when?
What were you thinking? Any other times?
Did you let the researcher know that you were thinking about SQUARE ONE TV? How? If no, why not?

29. Is it worthwhile for people to watch SQUARE ONE TV? Why or why not?

30. Do you have anything else that you'd like to tell me about SQUARE ONE TV?

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31. If "Mathnet" not favorite: What do you think about "Mathnet"?

32. Can you explain to me what "Mathnet" has to do with math?

33. Remember Kate and George on "Mathnet?" If you were to ask them to explain what math is, what do you think they'd say? [Probe here for use and importance.]

34. How do you think Kate and George feel about math? Why?

(Return to Q11)

That's all the questions that I have for you. Do you have any questions for me? You've been very helpful. Thanks for helping me today.

APPENDIX IV.D:

SQUARE ONE TV Interview Codebook

SQUARE ONE TV Interview Codebook

Introduction

This codebook will outline the method used in coding the **SQUARE ONE TV** (SQ1TV) Interview data; it will describe the process of thematic analysis, define the themes and subthemes that were identified in the data, and explain how to code for these themes and subthemes. Examples of codable responses are provided.

Thematic Analysis

As described in Chapter 1 of this volume, thematic analysis was the method used to analyze the SQ1TV Interview data. Much of the information about how and why this method was used is included in that chapter. The discussions of each theme, found in chapters 3-8, were created from the thematic analysis. It is important to note that thematic analysis preceded the piecing together of ideas for the text. Thus, while some ideas appear somewhat differently in the discussions of each theme, they are based on the thematic analysis that is outlined here.

Process of Thematic Analysis

The process of thematic analysis involves the following steps:

1. Print out a child's responses to all of the interview questions.

2. Read through the entire interview text, noting places where the child seems to return to ideas expressed earlier. Get a sense of the entire range of issues the child raises. Consider how well you believe you understand what the child was talking about.

3. Read through the interview text a second time looking for evidence of Theme A, SQ1TV and Fun. Underline or mark passages in the text that you understand to provide evidence of Fun or one of its subthemes. Do not try to discriminate between subthemes at this point. Instead, work to identify all statements that represent the theme of Fun. A description of this and the other five themes: B, SQ1TV and Education; C, SQ1TV and Problem Solving; D, SQ1TV and Mathematics; E, SQ1TV and Participation; and F, SQ1TV and Applications of Mathematics and Problem Solving, is provided in the next section.

Note that while certain questions may be more helpful than others in eliciting certain themes, this is not a coding scheme geared to specific questions. Instead, the entire interview text should be read as containing evidence of each theme.

4. Repeat this process, reading the entire interview for each successive theme and marking passages in the text. (You will end up reading the text a total of seven times: once to get a sense of the text and six more times for the six themes.)

After identifying a response (i.e., the answer to an interview question and its follow-up probes) as evidence of a particular theme, label it in the margin (Fun - A, Education - B, etc.). Within a given response, there may be, e.g., different "Fun" passages; these should be labeled A1, A2, A3, A4, etc. With a new response, you should begin numbering with A1 again.

It is also important to note that passages can be double or triple coded, as containing evidence of more than one theme.

5. For each interview (child), collect the evidence of each theme so that you have a cluster of quotes, ideas, etc. related to each of the six themes for each child. This is done to get a larger sense about how each theme is elaborated within the interview of a given child.

6. For each cluster of quotes, ideas, etc. gathered for each theme, distinguish between the subthemes. Label the quotes that represent a given subtheme. (The subthemes are numbered.) You may end up with quotes that don't fit exactly into one of the subthemes listed; not all of the data that seems to fit within a given theme may fit in with the subthemes focused upon in this analysis. This is not a problem in that such quotes or ideas are often very general statements of the theme or idiosyncratic twists on the theme. Focus on the subthemes that are described in the next section of this codebook.

You will come across negative examples of a particular subtheme when a child may say that "I didn't really do the problems." This would be a negative example of the Theme of Participation, an example wherein a child talks about choosing not to participate in SQ1TV.

Themes

This section provides descriptions of each of the six themes and their subthemes. Examples were drawn from children's interviews.

A. Fun

Children explain that SQ1TV is fun and described various ways in which they experience the series as fun.

Subthemes:

1. Humor

   By referring to the dialogue or the action of the series, children remark on the humor in SQ1TV. They comment on the jokes and the parodies observed on the series. The focus is on the elements of the show that made the children laugh or that they found to be amusing. This also includes more generic comments about the series being "funny" or "fun to watch."

   Examples:

   "[It] makes you laugh."

   "The bird said 1,1,2,3,5 in a funny way."

2. Change of pace

   Children talk about finding the series to be an enjoyable change of pace from school. It is fun because it is different, relaxing, or not boring, in comparison with school.

Example:

"You can just sit there and relax."

3. Entertaining

Children comment on the entertainment factor as a reason why they find the series fun. They talk about the magic or the tricks they see on the series as things they find to be fun. They comment on the similarity between the series' segments and other media, such as TV, movies, or cartoons, which they find to be enjoyable. In comparison with the humor subtheme, the focus here is on the quality of the series as entertainment, as something the children watch that entertains them.

Examples:

"[They make SQ1TV to] keep you entertained."

"It's just that's like...[SQ1TV is] like a television show and they make it fun using...they just make it fun."

B. Education

Children talk about the ways in which they find SQ1TV to be educational, that it teaches them about mathematics, or gives them an opportunity to reflect upon their process of learning. This theme picks up ideas about how the children learn mathematics and how they are taught mathematics from SQ1TV.

Subthemes:

1. Mathematics focus

Children talk about the mathematical focus of the series.

a. SQ1TV teaches mathematics

Examples:

"They want you to learn math."

"They're just trying to teach you more about math, because the whole 'Square One's' dealing with math."

b. Mathematics and fun

Children comment that, as a result of viewing SQ1TV, they realize that mathematics can be fun and, by extension, learning mathematics can be fun.

Examples:

"At first, I thought you couldn't use it in a fun way, but then later, when I saw SQ1TV, I got to the hang of it, that it's, like, fun."

"[It's worthwhile to watch SQ1TV] 'cause it teaches you, and it's funner and...you learn from it and it's fun."

2. Pedagogy

SQ1TV is perceived as an educational series that teaches mathematics. Children comment on the ways in which they learn mathematics from the series. The emphasis here is on the process of learning.

a. There are different ways to learn mathematics

Children indicate an awareness, often through comparisons (implicit or explicit) between the series and school, that there is more than one way to learn mathematics. Children talk about the different (and sometimes new) ways in which they learn mathematics from the series. These include playing along with the series and doing work in their heads. It can also include comments in which the children point out that more school-based approaches, such as listening to the teacher, doing work-sheets or papers, are not found on SQ1TV.

Examples:

"In school we just do it, right. They teach us and we just do it. [On SQ1TV] they start using it in a fun way, like kinder[gartners], they use them in little stories and all that."

"When you watch 'Square One,' it's funner and you can understand it a bit more better. They make [math] different and into singing. We just read it or something. They sing and dance about it."

b. There are different approaches or steps to the same answer

Children comment on the possibility of arriving at an answer through using different steps or methods, i.e., they acknowledge that there is not one single way to do all problems. This includes the discussion of various steps one might go through to solve a problem as well as comments about how the series explains or demonstrates the various steps it follows in solving problems.

Examples:

"They use the same steps, not all the same steps, 'cause they might use a different step."

"Well 'Square One' teaches you...there's like different ways to do things...and well [SQ1TV] tells you -- like some -- both the ways, or, or...so you can figure it, so you can understand it better."

3. Reflection upon own learning

Children talk about the nature of their learning from SQ1TV. They make explicit reference to the kind of learning that happens (or does not happen) through exposure to the series, such as reviewing material or learning new concepts/skills. They talk about learning nothing new from the series or not retaining all of what was learned. They talk about the fact that what was learned has application to school, now or in the future.

Examples:

"'Square One' might help you if you really want to learn...if I want to do the problems...I really don't do the problems, I just watched to see how they do it."

"We learned different stuff from it...like you might learn how to figure out how somebody can get from one point to another point in a certain amount of time and which way's the easiest to go."

"'Square' One helps me to remember things that I've forgotten, like with decimals."

C. Problem Solving

Children talk about the problem solving they see on SQ1TV. This theme incorporates their own conceptualization of problem solving, the activity of figuring out, as well as problem-solving heuristics drawn from Goal II of the series.

Subthemes:

1. Problem solving is part of the nature or make-up of the series

Children comment on the appearance of problem solving in various parts of the series. They speak of "Mathnet" as a mystery to be solved and a case to be figured out. They talk about solving the problems posed on non-"Mathnet" segments, including problems they may identify as mathematics problems. They talk about the activity of problem solving that went into the PSAs. This subtheme includes commenting on problem solving as a major focus of the series.

Examples:

"Like on 'Mathnet' they had to figure out the problem, like what was wrong...I had to figure out what was wrong with the game."

"On 'Mathnet' they solve mysteries...and use math to solve the problem."

"Dirk...he's um a mathematician, and he always gets problems solved...he solves all the problems."

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2. Multiple problems

Children comment on the fact that there is more than one problem to solve, particularly in "Mathnet." They indicate an understanding that problem solving does not consist of working on a single, isolated problem. They make a distinction between "problem (human) problems" and "math problems." They point out the multiple processes that go into solving a problem or the step-by-step approach that one must use as examples of interconnected problems. They speak of mathematics, in SQ1TV, as a necessary component of those interconnected problems. They also speak more generally about mathematics as necessary for the problems they see on the series.

Examples:

"They're using math to figure everything out. Well the first ['Mathnet'] we watched was about this gorilla and it escapes and everything...and he kept on breaking into all those stores...and they had to figure out like...how far, okay because...he would hit one store and all the way across town he would leave and they had to figure out how fast a gorilla can run, how far he can get, and the time...he had been giving to those two places. And then they had to figure out if there was a way that he would have been able to get there, using numbers."

"They have to figure out math problems to get to the...problem."

3. Problem-solving heuristics

Children talk about how problems on SQ1TV were solved or how the characters went about solving problems. Using the descriptors presented in Goal II of SQ1TV, their responses can be classified as problem treatment (estimating, gathering data, recalling information), problem-solving heuristics (a. representing problems, e.g., mapping, graphs; b. looking for patterns, e.g., Fibonacci sequence; c. reapproaching problems, e.g., review material, keep working/concentrating).

Examples:

"They look for, um, puzzles...and they found the pattern in the wall...and found that there was five blocks in the wall -- and there was five going up...and then eight going up...and the last one wasn't following the pattern."

"They usually use a map to tell you who they're looking for. And they use inches, scales, and they use a whole bunch of division and multiplication."

4. Thinking

Children comment on the activity of thinking as part of problem solving. They note that concentrating, thinking, or using one's head is necessary.

Examples:

"You really had to think...to answer their question, their problems."

"'Mathman' has to think in his head...to work the answer out in his head before he answers it right or wrong."

D. Mathematics

Children talk about the presence and the importance of mathematics in SQ1TV. They speak about mathematics in conceptually distinct ways. Goal III of the series is used to distinguish between different mathematical concepts. The emphasis here is to highlight the ways in which children elaborate or list ideas about mathematics.

Subthemes:

1. Mathematics is integral to the series

Children comment on ways in which mathematics is central to SQ1TV.

Example:

"They're never using up a different subject about how to take care of your bodies and stuff like that from health...they're always singing songs about circles or fractions and everything."

"The whole show you're using numbers, and you have to figure things out."

"'Square One' is mainly about math...like every video they showed has to be about math."

2. Arithmetic operations

Children talk about mathematics as arithmetic, focusing on computation and often interchanging "math" with "addition, subtraction, multiplication, division." They equate mathematics with arithmetic as they offer their own definitions, as they speculate on how Kate and George would describe mathematics, and as they define mathematics in a school context. These references to mathematics as arithmetic can also occur within a statement where they go on to talk about other mathematics concepts, such as those described in Subtheme 3, below.

Examples:

"What does math mean. I don't know, just problems, you know, division and all that and times and I think that."

"In 'Mathnet,' they start calculating things, divide, multiply."

3. Mathematical concepts beyond arithmetic

Children talk about mathematical concepts that are distinct from basic computation. As outlined in Goal III, these mathematical concepts include fractions, inequalities, decimals, geometric shapes, percentages, powers, squares, and simple equations, among others.

Examples:

Note that what would be marked for this subtheme are the mathematical concepts other than arithmetic operations; in this first example then, fractions, decimals and geometry would be coded as evidence of the subtheme.

"[Kate and George would say mathematics is] about division, multiplication, fractions, decimal numbers, all those -- geometry."

"They're singing about like decimals or something and decillations [sic] and stuff like that and um, they do mostly everything with math."

"They're just teaching you a whole bunch of things in math...like decimals, octagons, polygons, there's a lot of things."

E. Participation

Children talk about the ways in which they participate in SQ1TV. These responses include comments about the engaging nature of the series, and focus on the attributes of the series that hold the children's interest or invite their participation. They also include comments about the nature of the children's participatory activities.

Subthemes:

1. The series is engaging

Children talk about what makes SQ1TV engaging for them. They talk about how "Mathnet" creates suspense and sustains their interest, and about its intriguing story lines. They comment on the fact that the series is aimed at, and features, kids like themselves.

Examples:

"We wonder what is going to happen next and everything in 'Mathnet.'"

"There's some part like um 'Mathnet'? When you know like, it's a mystery...and they put it to be continued on an interesting part...To be continued, you know you know, the next day you watch the other part...the interesting part...you know like when they find something."

"[SQ1TV] has mostly like has kids in it...like there's game shows that kids come on, and like that."

2. Ways in which children participate

Children describe a variety of ways in which they take part in SQ1TV. They talk about the series or specific segments with their family, friends, or teachers. They try out something they saw or learned on the series with family or friends. They play along with the SQ1TV games, either on paper, in their heads, out loud, or with their classmates. They think ahead and try to anticipate the next

"Mathnet" episodes. They identify with SQ1TV characters or imagine themselves in their roles as they solve problems.

Examples:

"It's like they have games you can play along, and, it's just fun you have these game shows, it's like when you spin a wheel and whatever two numbers you get on, you can either add or subtract...and you can just play along with that...we do that at our desk."

"Like on the ['Mathnet'] with the parrot? I, 'cause, you know the parrot was always saying these numbers, like...'one, one, two, three, five, eureka' and I go --'I bet that's the, what do you call it? The combination to something, and the next day the man George said, 'That might be the combination.'"

"Sometimes in lunch we're talking about it [SQ1TV]...like what happened that day, or what you thought was going to happen."

F. Applications

Children talk about a variety of ways in which the mathematical and problem-solving ideas presented on SQ1TV can be applied. They talk about applications of mathematics within the series itself, as well as applications to "real life." The emphasis in this subtheme is on the mathematical ways in which the concepts of the series are used.

Subthemes:

1. "Mathnet" applications

In response to direct questions, children talk about how Kate and George use mathematics (applications) and how they feel about mathematics (attitudes). They comment on the different ways in which the Mathnetters apply mathematics and problem solving in their cases.

Examples:

Kate and George "like math a lot...they're always using it...math helps them, like it's a piece that belongs to them."

"Kate and George probably like looking for things and helping...and using math...it's fun on their job. They get to go to places and do things interesting."

2. Non-"Mathnet" applications

Children talk about how SQ1TV characters (other than Kate and George) use mathematics and problem solving in their SQ1TV lives, or the children discuss extrapolations of these uses to "real life." Children also make generic reference to SQ1TV as a whole, without reference to specific characters. The focus in this subtheme is on examples in which children make explicit or strongly implicit references to the series as they describe applications.

Examples:

"Dirk Niblick points out how people could get cheated, like I could get cheated if I can't count money at the store."

"Like on 'Oops!,' that, the one 'Oops!.' They're building constructions or something and they tell what kind of things to do."

3. Applications without reference to the series

Children talk, in a general way, about how mathematical and problem-solving ideas that are part of the series' agenda can be applied to "real life." These comments are made without explicit reference to SQ1TV or its characters. The focus in this subtheme is on examples in which the children talk about ways in which they or "real people" could use mathematics or problem solving.

Examples:

"You use math and counting if you want to buy something for yourself and you need to figure out if you have enough money."

"You can use it for work -- you can work at an office and you probably sell goods to other countries. And you have to know how much goods to sell."

APPENDIX IV.E:

Interrater Reliability

Interrater Reliability

To ensure the replicability of the coding used for this analysis, two raters independently coded six of the 24 interviews for each of the themes and subthemes under consideration. Reliability was assessed in two ways: via the percent agreement between the two raters and via Cohen's kappa (Cohen, 1960), an adjusted measure of agreement between raters.

We report the results of these reliability analyses below. However, one point should be noted with regard to the use of Cohen's kappa here. The computation of Cohen's kappa is such that a perfect score requires some variability in the behavior being coded; some subjects must be coded as exhibiting this behavior and others coded as not exhibiting it. Because some of the themes and subthemes were discussed by all or virtually all of the children in the sample, kappas were not computable for all of the subthemes used (despite perfect agreement between raters in these instances), and kappas of 0 were obtained for some subthemes in which the percent agreement was near perfect. Thus, the kappas reported here should be interpreted with caution and taken as a very conservative estimate of the agreement between raters.

Percent agreement and kappas were computed for each subtheme individually and then averaged across the subthemes within a given theme to produce a mean score for that theme; note that since kappas were not computable for some of the subthemes, not all kappas could be included in these means (although all kappas of 0 have been included). The mean scores are reported in the following table:

Theme	Mean kappa	Mean percent agreement
Fun	.83	94%
Education	.63	89%
Problem Solving	.50	88%
Mathematics	.00	94%
Participation	**	83%
Applications	.57	94%
Average	**.51**	**90%**

** NOTE: Kappas could not be computed for any of the subthemes within this theme.

As this table indicates, on average, the raters agreed 90% of the time; agreement was 83% or higher for every theme coded. Thus, we felt confident in the reliability and replicability of the coding scheme.